Department of Science and Agriculture

BARBADOS

AGRICULTURAL JOURNAL

Vol. 8, No. 1. January, 1939.

Advocate Co., Ltd.,—Printers & Bookbinders to the Government of Barbados.

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REPORT ON THE WORK OF THE DEPARTMENT OF SCIENCE AND AGRICULTURE

for the Year ending the 31st March, 1939.

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MANURIAL TRIAL WITH SEA ISLAND COTTON.

BY

S. J. SAINT, M.Sc., Ph.D., F.I.C.

Manuring of sea island cotton is not generally practised in Barbados. Cotton is taken as a catch crop on sugar cane land, and the inherent fertility of the soil is considered sufficient to grow the maximum crop of cotton. Since there is no experimental evidence to justify this assumption, it was considered desirable to carry out a manurial trial. Previous work in St. Vincent has indicated that nitrogen is the principal limiting factor, so the trial was planned to test the effect of nitrogen as sulphate of ammonia by itself and in combination with potash and with potash and phosphate.

VARIETY OF COTTON.

The variety of cotton chosen was Barbados Sea Island.

SIZE OF PLOT.

The plots were each forty-two cane holes or 0.03 acre.

PLAN.

The trial was laid out in the form of four randomised blocks. There were four treatments, as follows:—

Plot 1—No manure.
" 2—2 cwt. sulphate of ammonia per acre.
" 3—2 cwt. sulphate of ammonia + 1¼ cwt. muriate of potash per acre.
" 4—2 cwt. sulphate of ammonia + 1¼ cwt. muriate of potash + 5 cwt. superphosphate per acre.

METHOD OF PLANTING.

The seed was planted according to the close spacing method advocated by the Department, i.e. six chops per cane hole and two plants were allowed to grow to each chop.

PLANTING AND REAPING.

The experiment was planted on 30th September, 1937, and the cotton was reaped between 21st February and 5th April, 1938.

YIELD RESULTS.

The yield results are set out in Table I.

TABLE I.

Treatment.	Blocks 1		Blocks 2		Blocks 3		Blocks 4		Totals.		Means.		Seed Cotton Yield per acre.	
	lb.	oz.	lb,	oz.	lb.	oz	lb.	oz.	lb.	oz.	lb,	oz.	lb.	oz
1	31	4½	27	12½	31	2½	33	3½	123	7	30	14	1,280	4
2	45	14	36	15	35	3	39	12	157	12	39	7	1,635	2
3	40	5	36	9	39	5	36	7	152	10	38	2½	1,582	8
4	41	6	39	0	39	2	43	4	162	12	40	11	1,687	8

CONCLUSIONS.

1. VALUE OF NITROGEN AS SULPHATE OF AMMONIA.

The yield of the no-manure plot, viz. 1,280 lb. seed cotton per acre, is an exceptionally high one since a good average yield of seed cotton in Barbados is generally considered to be about 800 lb. per acre. It is therefore probable that the land on which this experiment was carried out was in excellent condition. Notwithstanding this conclusion, it is seen that an application at the rate of two cwt. of sulphate of ammonia per acre has increased this yield by about 28% or 355 lb. seed cotton per acre. If the seed cotton is valued at seven cents per lb. the value of this extra yield works out at $24.85 per acre, whereas the cost of the manure was $4.20 per acre.

There is no doubt therefore from the results of this experiment that the application of sulphate of ammonia to cotton will yield economic returns. It is probable that on less rich soils the percentage increase would be even greater.

2. VALUE OF POTASH AND POTASH PLUS PHOSPHATES.

It is evident from the results given in Table I that neither potash alone nor potash plus phosphates in addition to the nitrogen has had any significant effect in increasing the yield of the cotton. Nevertheless, it is considered desirable that this experiment should be repeated on a less fertile soil before it can be definitely stated that potash and/or phosphatic manures are, in all cases unnecessary for cotton.

COTTON GROWING AND COTTON PESTS CONTROL

BY

R. W. E. TUCKER, M.A., B.Ed.

Cotton growing in Barbados is largely governed by insect pest control: other factors are the price obtained for the product, the increased ratooning of sugar cane which is now possible, and a disinclination on the part of the average plantation management to plant and look after cotton.

Were there no insect pests, yield per acre would offset the price factor and the crop would, moreover, cease to be a troublesome one controlled largely by legislation.

There are two outstanding facts concerning cotton in Barbados. Firstly, that insect control is both possible and economic, and that given adequate pest control, the yield per acre on right soils properly manured is a paying proposition. Secondly, cotton should have a place in the crop sequence of the Island, both as a cash crop for the peasant cultivator and a paying short period rotation or resting crop on sugar estates.

Control of cotton pests will never be obtained without regular spraying with arsenicals and adherence to the legislation which governs cotton growing.

Proper facilities exist in the Island for the purchase, ginning and export of the cotton. Import Regulations for the prevention of pest introduction in cotton seed, lint, etc., are at least the equal of Field Regulations and are enforced. Suitable seed supplies are maintained by the Department, fumigated, stored, tested for germination and issued at the planting period. Advice on cultivation and demonstrations in spraying technique can always be obtained from the Department. The acreage planted in cotton, however, depends entirely on the willingness of planters and small holders to grow the crop, and has decreased.

In the following short account, cotton growing is dealt with under four headings. Planting (method and time of year), Insect Pest Control, Close Season for Cotton and Destruction of Cotton Residues and of Host Plants.

The statements regarding recovery of Pink Boll Worm from material collected at random throughout the fourth month following the promulgation of the close season are based on the dissection of 20,000 seeds in 1937 and 1938. Observations on okras and Pink Boll Worm are based on the dissection of several thousand okra pods at various times.

The close season for cotton has, since 1928, (1) always coincided with the rainy season in Barbados, and the conclusions drawn below are based on several years of observation on cotton growing and cotton pest control in Barbados.

Planting of Cotton—Method and Time of Year.

Method of Planting Cotton. This always has and will depend upon the primary use of the fields for growing sugar cane. Fields are always lined off in cane holes, which vary from 1,200 to the acre to over 1,700 to the acre, according to soil and locality. The seed is planted in chops in the banks between cane holes: 6 chops to the hole and 3 seeds to the chop. The fields are always free of weed, the suppression of weeds being both an article of faith and a means of giving employment to labour in Barbados. When the cotton plants spring, they are thinned out at an early stage to a maximum of two plants to a chop. The planting of wind-breaks such as a narrow but dense belt of guinea corn is always recommended on the windward borders of fields. The advantage of wind-breaks is definite.

Time of Planting: This has been regulated since 1929 to a period of three weeks which is fixed around the beginning of September. At this time of the year the maximum rains are, normally over; but adequate rains should fall during the growth of the crop to ensure proper development, flowering and fruiting, and normally, when the bolls open the weather should be comparatively dry. Harvesting, therefore, takes place usually in January to February, but owing to the prolonged bolling habit of Sea Island cotton, may last much longer. Normally, cotton picking should be completed by March, and fields have to be cleaned of cotton by the end of April, giving May to August as a four months close season. This sequence is well suited/to cotton growth and yield, and to pink boll worm control in Barbados, but is stated to be not so well suited to plantation practice.

In the first place, before the advent of Pink Boll Worm in Barbados, planters were accustomed to plant cotton in June, and to allow the cotton trees—and literally they often were trees—to remain on the land for around eleven months. Under such conditions, and in the absence of Pink Boll Worm, large yields per acre picked leisurely over a considerable period, were possible. The plants, of course, often suffered from black arm, angular spot and bacterial boll rot due to growing throughout the main wet season, but the long cropping period offset these disadvantages. With the advent of Pink Boll Worm, it was impossible to have cotton growing throughont the year and from 1928 onwards the growing of cotton was regulated. A close season of over a year was first instituted in 1928-29 (1), and during this period all wild cotton plants were sought out and destroyed by the Plant Diseases Inspector and his staff. The date of cotton planting was then fixed from around September 1st as already stated and at first, with closer planting, good crops were obtained and, following the long close season and cotton clean up there was very little pink boll worm. For various reasons, the minimum four months' close season was not always obtained and the incidence of Pink Boll Worm subsequently increased. This lessened yields ; also, with a short and defined cropping period, control of its defoliator *Aletia (alabama) argillacea* became more important and these factors, coupled with a dislike of being restricted to planting late in the year, instead of early and the consequent coincidence of cotton picking with cane reaping, put cotton into disfavour, which was accentuated by the price the crop fetched.

The facts, however, are that cotton can be grown profitably at present prices and, if it is properly grown, and with the abundant labour supply of Barbados the co-incidence of cotton picking and cane reaping does not seem to be an *insurmountable obstacle*.

INSECT PEST CONTROL.

From planting, the next stage is pest control. Attack by the defoliator *Aletia (alabama) argillacea* seldom develops into serious proportions until most of the plants in a field are near or at the flowering and bolling stage. The usual practice in Barbados is to wait for an attack, and then to dust the fields with Paris Green and lime mixture. If dusting is delayed by failure to perceive that defoliation is taking place, or by rains, or by a week-end or other diversion of plantation labour, then serious damage results. If plants in whole fields or sections of fields are not entirely killed by defoliation, they are at least so set back in reproduction that they do not blossom and boll again until some weeks later. Such set back fields are always a source of trouble in that they invariably suffer more severely from Pink Boll Worm attack, give poor yields, and tend to struggle over the time limit for cleaning fields of cotton.

Dusting, therefore, though decidedly better than nothing, should be replaced by wet spraying.

The advantages of wet spraying in Barbados completely outweigh those of dusting. Lead arsenate spray, with sticker, will protect the plants for some weeks according to rainfall, growth and severity of attack and will not scorch the plants as Paris Green dusts sometimes do.

A properly applied spray will withstand several downpours of rain, whereas the first moderate shower removes most of any dust applied. Lead arsenate spray can, therefore, be applied at any time chosen by the grower *before* defoliation starts; moreover, three properly applied sprays will completely protect the crop, and therefore the planter's obligations in the matter of material and expense are defined.

It is difficult to secure a change over from the accepted practice of dusting with Paris Green and lime, because dusting needs no special equipment: frequently any piece of sacking is used as a dusting bag. Trained workers are also dispensed with and women and children are often employed to apply the dust: also, the materials are easier to mix in bulk and to transport to the fields

Various hand dusting machines have been tried out, to make dusting, which planters apparently prefer, more effective, but the machines usually have too short an effective life with the labour employed.

To effect a change over to spraying, it has been necessary to find an efficient portable sprayer, cheap enough to discount the probability of a short life due to inadequate care, and also to get lead arsenate stocked on a commercial scale at a price approximating the wholesale purchase price.

Suitable portable compressed air sprayers, easily filled and handled, can now be purchased, delivered to plantations, for £1. 13. 0. or, in better quality material, for £2. 10. 0. each* Lead arsenate is now stocked commercially, and molasses, which is used as a sticker for the spray, can be obtained by anyone.

Demonstration in spraying technique and trial field sprayings will always be given by the Department on request.

The cost per acre of cotton for three adequate sprayings has been worked out in test experiments at 10/- per acre per spraying, including untrained labour. With trained workers spraying, this amount could certainly be reduced owing to less time being taken and less spray wasted.

In the tests made, three sprayings completely protected the crop, despite rains, and despite a heavy infestation of *A. argillacea*, and *Zylomyges eridania* which appeared prior to one spraying.

Protection against cotton defoliators is, therefore, a definitely reasonable and economic proposition in Barbados.

The measures for Pink Boll Worm control are standard. First, Import Regulations governing the import of cotton seed and raw or unprocessed cotton products, so as to prevent the entry of Pink Boll Worm or any other insect pest of cotton. Ginnery inspections and Field Regulations for the control of existing Pink Boll Worm in the Island by means of close seasons, regulated plantings and field sanitation.

It is realised that Regulations are not made with the purpose of hampering trade or the growing of cotton, but to assist in the economic growth and in the protection of a necessary crop for the Island.

The Department, therefore, uses discretion in the application of Regulations and is willing to investigate any special cases on request, and, if warranted, to recommend or allow reasonable latitude if the Director of Agriculture is satisfied that no danger can result from considering any legitimate individual interest.

The Field Regulations stated above should present no difficulties to either plantation or small holding cultivation.

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* Subject to currency fluctuation.

The regulation of planting has already been dealt with: close season and field sanitation are considered below.

CLOSE SEASON FOR COTTON.

With the close season is associated a controlled season for edible okras as mentioned later.

A close season of four months, coinciding with the wet season, and the gathering up and destruction of cotton residues is necessary in Barbados for the following reasons:—

It has been clearly shown by field collections and records made by the writer that in Barbados, Pink Boll Worm can survive in the field for a full four months; after that, it has been difficult to obtain sufficient samples of field residues to determine the possibility of live Pink Boll Worm being present.

As stated above, fields in Barbados are kept almost entirely devoid of weed; cultivation is definitely clean. Collections of fallen bolls and lint containing seed were made in such fields, and in fields which had been manured and planted in yams or eddoes following cotton, also in grassy borders surrounding cotton fields, and in places where cotton residues had been 'dumped' out of sight. Living Pink Boll Worms were obtained from one source or another up to four months after cleaning of fields. Laboratory tests made in a previous year, had shown that the moths emerged from material kept in jars up to 3½ months from commencement of close season. Many Pink Boll Worms died when kept under such conditions.

There is no doubt that most of the Pink Boll Worm population in cotton bolls, lint, etc., which escapes the field clean-up, or which is dropped or blown out of the fields by the prevailing trade winds, does perish from natural causes or pupates and hatches into moths which find no host plants in the close season.

The only known host plant of any consequence in Barbados is the edible okra. *Hibiscus esculentus*. This is grown largely in small holdings, and, in one area, on a plantation scale under irrigation.

The edible okras have to be picked within three days of the flowers withering, in order to be edible. After that, they become too tough, and the practice was to leave them on the plants for various periods until they were picked to get rid of them, or to use as stock feed.

It was in these old inedible okras that *P. gossypiella* found an alternate host, if they were left on the plant for a sufficient period.

As mentioned above, it has been found that, despite the fact that the close season always has coincided in Barbados with the rainy season, some Pink Boll Worms do survive in cotton residues in the field and therefore may carry over in okras.

Okra growing is, therefore, controlled by planting only under permit and inspection, for a longer period than, or overlapping, the cotton close season.

There is no restriction on okra growing but, with the permit system, the locality of okra plots is registered, and plants are inspected periodically to see that no old okras are left on them. As the inedible okras can be used as stock feed, and it is more advantageous to pick them before they become inedible, okra growers of all classes readily see the advantage of keeping their plants free from fruits which may harbour Pink Boll Worm, and thereby call for the destruction of the plants.

Close season and okra control, if carried out properly, reduce the carry over to such small proportions that the major portion of the cotton crop can be picked before Pink Boll Worm causes any economic damage.

DESTRUCTION OF COTTON RESIDUES.

The close season for cotton is usually proclaimed from May 1st to August 31st. The usual practice is, therefore, to uproot the cotton plants in the fields (or to chop them below soil level) early in April, or, better still, as soon as each field has completed its economic yield. The bushes are allowed to dry in the fields, piled up in heaps *in situ* and burned. At the same time, fallen bolls and lint are swept up by small hand brooms of twigs and thrown on to the piles.

The sweeping of fields was found to be inefficient, and it has been shown that the same amount of labour can, by hand picking the fields and borders of bolls and lint, under supervision, effect a clean up from which practically no residue can be found by subsequent searches.

It is considered by some authorities that the burning of cotton plants is a drain on soil fertility, and that the plants should be ploughed under instead. The type of ploughing in Barbados is not thought by the writer to be suitable to the adequate burying of cotton bushes, nor is the rate of plant decomposition, particularly of a woody-stemmed plant like cotton, sufficiently rapid in Barbados. Quite apart from inadequate destruction of Pink Boll Worm, the fields would be needed for short period catch crops, or for return to cane, before the ploughed in bushes had disintegrated.

The removal of the bushes for making into compost or pen manure, is also not advocated, unless *all* bolls are first removed in the field of growth and burnt in such fields with hand-picked cotton residues. To remove plants and bolls from fields would only add to the difficulty of reducing pink boll worm population to the lowest possible level during the close season.

The present practice of burning *in situ* is recommended, and soil fertility can be adjusted by a cover crop, trashing and manurial practices standard for Barbados.

SUMMARY.

Cotton growing in Barbados has declined in favour during past years for several reasons. The severe losses sustained from Pink Boll Worm attack and other cotton plant pests a decade ago necessitated a short growing season for cotton a minimum close season of four months coinciding with the wet season, and a strict clean up of cotton residues in fields. The practice of burning cotton plants and gleaned residues *in situ* is considered best suited to the agricultural practices of Barbados.

The change from a long growing and picking period to a short one defined in time, was accomplished by legislation governing time of planting and time of destruction of the crop and residues.

The shorter growing period made it more imperative to control defoliators. as the effect of any severe defoliation was to delay the fruiting of the plants to an extent that fields would not remain productive or reasonably free from *P. gossypiella* within the limits of the growing period.

Control of defoliators (*A. argillacea* and *X. eridania*) has been rendered more difficult in Barbados by adherence to old fashioned methods of dusting with Paris Green and lime.

Light, portable, efficient compressed air sprayers and commercial stocks of lead arsenate are now available at reasonable pri es. Demonstrations in proper spraying technique are always available and the change-over to wet spraying with lead arsenate and sticker is advocated.

Both cotton Regulations and spraying can easily be made ordinary plantation routine, and with insect pests controlled and cotton planted on right soils of proper fertility, paying crops can definitely be obtained, and cotton as a short period crop should have its place in the Agriculture of the Island.

REFERENCES.

1. 1928—31. Tucker, R. W. E. .... Department of Agriculture, Barbados, Annual Report of the Entomologist, 1928-29, 1929-30, 1030-31.

THE CONTROL OF DIAPREPES ABBREVIATUS L. AND LACHNOSTERNA (PHYTALUS) SMITHI ARROW, IN BARBADOS SURVEYED OVER A PERIOD OF ELEVEN YEARS.

BY

R. W. E. TUCKER, M.A., B.Ed.

These two insect pests, known respectively as root borer and brown hard back, damage the roots of sugar cane in Barbados.

The root borer, *Diaprepes abbreviatus*, causes more serious damage in that the larval stages bore into the subterranean portions of the cane stems as they mature as well as feeding on the root system during the younger larval stages. The larvae also attack cane "plants" or "seed" at the time of germination and cane "spring."

The effect therefore is to cause portions of fields of newly planted cane to be ruined, necessitating late replanting; also to affect mature ripening cane, causing stools to dry up and turn brown prematurely, so that whole fields or portions of fields have to be reaped prematurely or allowed to die. In addition, it can prevent ratooning of canes by causing the death of ratoons or such a poor and irregular growth that the ratoon fields have to be dug up.

The brown hard back, *Lachnosterna smithi*, is not considered to be so harmful, in that it does not bore into the solid root portions, but feeds on the fibrous root growth. By cutting the root system, it (in conjunction with root borer) often causes stools of cane to topple out of the soil before reaping, and in general is very detrimental to the plant growth. It also has many other host plants, and can damage sweet potatoes (root borer grubs also do so sometimes) and is a garden pest as well, feeding on the roots and foliage of various plants and vegetables.

Diaprepes abbreviatus is known in several West Indian islands and in St. Lucia for example it is largely a pest of citrus trees. In Puerto Rico it is a pest of both cane and citrus, but is more conspicuous in citrus. In Barbados, citrus growing is negligible (certainly so for the period reviewed) compared with sugar cane, and though *Diaprepes* undoubtedly does and will attack citrus, the writer has not seen the damage to citrus, and the numbers of *Diaprepes* in the open in Barbados that he has in Puerto Rico, and the damage by root borer has been entirely a cane growing problem.

In addition to citrus, *Diaprepes* larvae attack the roots of maize, imphee, guinea corn, etc., and have been dug up from roadside grass banks and sour grass (*Andropogon pertusus*) pastures. As mentioned they will also attack sweet potato, but this is possibly adventitious, and not a true habit; similarly with larvae recorded from ground nuts, and from roots of *Pithecolobium*, etc.

Adults of *D. abbreviatus* are not conspicuous feeders: they feed to a small extent on sugar cane leaves, making characteristic ragged, frayed or lacerated chewed out portions, and also on the foliage of pigeon pea bushes (*Cajanus indicus*). They also feed extensively on citrus foliage, particularly of young trees, but so far do not appear to have discovered citrus as a regular source of food supply in Barbados. Wolcott (13) records their feeding on numerous other host plants in Puerto Rico.

It is important to stress that Barbados is practically an undulating cane garden, in which, where cane will not grow, sour grass pastures are planted; even the road sides are usually planted with grasses reaped for stock feed, etc. Waste or bush land is practically unknown, and masses of trees, wherever they exist, are invariably *Swietenia mahogani* which is not a host of *D. abbreviatus*.

Evergreen trees *Ficus lentiginosa* and *F. nitida* occur near some plantation houses for shade and ornamentation, but *D. abbreviatus* does not frequent them to an extent which has enabled the writer or any one else as yet to find them there.

It can be safely said therefore that for the period under review *D. abbreviatus* is practically a specific cane pest in Barbados.

For the same reasons *Lachnosterna smithi* is also mainly a cane pest, though it undoubtedly has a wider feeding and oviposition range if it can find it. The writer has, however, never seen roadside trees, banana trees etc., with heavy *Lachnosterna* feeding evidence, such as he has seen in Puerto Rico.

L. smithi (or allied species or genera of this large group known as May beetles or June Bugs) has a much wider distribution than has *D. abbreviatus*. *L. smithi* is surmised to have reached the West Indies from the South American continent, and it is beyond surmise that it has reached Mauritius from Barbados presumably in new cane varieties accompanied by soil. In Mauritius it is a major cane pest (9 & 16) but not only is Mauritius about four times the size of Barbados, but it is doubtless very different in its available range of host plants, extent of bush, forest, or other uncultivated land, type and density of population per acre, and general intensity of cultivation.

These preliminary statements are necessary owing to the apparently, general lack of appreciation both in Barbados itself, and possibly outside as well, of the complete difference in host plant association, extent of principal host and lack of alternate hosts, intensive cultivation, and population density per square mile which are unique factors in Barbados.

These factors exert an appreciable difference in the recommendations for economic control of the pests, including that vexed question of efficacy of "hand collection": also, due to the absence of suitable roadside or waste ground flowering plants, on the chances of success of introduced Scoliid parasites of *Lachnosterna*.

DIAPREPES ABBREVIATUS.

The adults of this Curculionid beetle are striking looking insects cream or buff in colour with narrow ridges running lengthwise down a portion of the closed elytra: the body usually has a metallic bronze green sheen as well. There is no dimorphism, the males being similar to the females, but smaller, and distinguishable by a slight difference in the posterior ventral tergites. In addition to the males being slightly smaller and more slender, there is an appreciable variation in size due to nutritional factors in the larval stages. A well developed female is, however, about eight-tenths of an inch in length, and a little over three-tenths in breadth across the elytra.

The description is not intended to be specific, but merely an indication of the general size of the adult when hand picking is discussed, and of appearance, because of the confusion which still exists in some quarters in Barbados, between this insect and *Metamasius sericeus*, also a weevil, and also a sugar cane pest. Both beetles have been referred to by planters as "lady birds".

Metamasius sericeus is however smaller in size, dark brown and black in coloration markings, and is a pest of cane stems, not of the roots. Both adults, pupal cocoons and larvae, can be found in cane stalks which have been broken and are dying, which have been damaged in some way, affording access for egg laying, or which are dead, or have been cut and left as refuse in the cane fields. *Metamasius* will also attack ratoon stools in some cases, penetrating by the cut ends of the cane stalks.

This divergence is necessary because confusion does exist in some cases in Barbados between *Diaprepes* and *Metamasius* and damage attributed by plant-

ers to root borer, has, on report to the Department and investigation, proved to be due to *Metamasius*, or in other recorded cases to termites, nematodes, or root disease.

Confusion also still exists in Barbados (despite attempts to correct it) between the larvae of *Diaprepes* which are legless, and the larvae of *Lachnosterna* which are different in shape, and have six distinct legs at the front of the body.

The life history of *D. abbreviatus* has been worked out fully in Barbados by the Rev. N. Watson (1) and in recent years an intensive study of *D. abbreviatus* in Puerto Rico has been made by Dr. G. N. Wolcott (10 & 12).

The only points which need emphasising in this paper are that the eggs of *D. abbreviatus* are laid in cane fields in Barbados between crossed tips of a split cane blade, or of two separate blades. These crossed tips are quite easy to find after a little practice (i.e. if an infestation is present) and can be collected in large numbers at a small cost by trained workers. Also root borer beetles do not start laying eggs until from three to seven days after emergence and can lay from 2,000 to 5,000 eggs in a period as short as two months or as long as seven months. Both factors enable *regular* and organised hand picking of beetles and eggs to have a high chance of success.

LACHNOSTERNA SMITHI.

The generic name of this species alternates between *Lachnosterna* and *Phytalus* and is still known to most people in Barbados as *Phytalus*.

Its life history is described by B. A. Bourne (5) and a survey of its status and native parasite is given in 1932 by R. W. E. Tucker (6).

The name brown hard back common in Barbados is more descriptive than May bug or June bug; moreover in Barbados rainfall distribution is such an important factor that the adults may emerge over a period of several months, and the maximum emergences may be much later than May or June.

The principal characteristics of this pest, apart from those already mentioned, are that the grubs or larvae have legs, the adults are not seen by day, being almost entirely nocturnal in habit, and are also attracted to lights which frequently make them a nuisance to other people as well as to cane planters. Also, the eggs are laid singly in the soil, and not in batches or clusters between leaves as with the root borer.

Brown hard backs are not confused with anything else in Barbados, save very rarely with the black hard back, *Ligyrus tumulosus*, which to present knowledge is not an agricultural pest, but is found in pen manure, rotting vegetable matter, etc., and is thus sometimes distributed to and found in, canefields. The confusion however is rare, and not important.

OCCURRENCE OF D. ABBREVIATUS AND L. SMITHI.

The only methods of assessing the prevalence of both pests is by the annual records of hand collections, and of damage to canes by the reports of planters, or surveys made, of ripe cane fields which show characteristic root borer damage, of newly planted fields which die out in patches due to root borer attack and of ratoon fields which fail and have to be dug up or "thrown out" due to root borer and brown hard back attack.

To attempt an island survey of population of both pests has been considered, but the cost and organisation of adequate collections of adults and sampling of soil, in the necessary proportion and distribution of sampling is prohibitive.

The laying out of replicate plot experiments is also neither practical in the opinion of the writer after a study of agricultural statistical operations as applicable to insects, nor likely to produce worth while results, because of the

very large experimental error due to uncontrollable factors, especially in the case of such highly mobile insects.

The "assessing factor" of damage to cane fields is of only partial value because frequently the unseen grubs or larvae in the soil cause damage which falls just short of the maximum damage resulting in premature death of ripe cane stools, ratoon stools, or newly planted canes and is therefore not observed nor reported. Also, when the canes in ripe fields start to die out in patches or whole areas, they are reaped as soon as possible, and the fact is not always reported to, or seen by the Department.

There remain the two factors of ratooning and numbers of beetles collected, for both are directly ascertainable.

If the populations of *D. abbreviatus* and of *L. smithi* have diminished due to control measures, then more ratooning should be possible. It must be borne in mind that with a high population of *D. abbreviatus* ratooning (even first ratooning, let alone second or third) is impossible in the shallower, drier, coastal, black soil and light texture soil areas.

So far as ratooning goes, the facts are that about 3,000 acres or apparently 1/12 of the previous sugar cane acreage, are now additional ratoons.

It will be granted that the stimulus to extra ratooning was economic and following the 1930-31 depression, plantation expenses were reduced by keeping fields in ratoons instead of preparing, weeding and replanting them. As just stated, ratooning is impossible with a high *D. abbreviatus* population even without the addition of *L. smithi* depredations. The inference therefore is that the population of *D. abbreviatus* has been reduced and that at least a partial and economic control over root borer and brown hard back has been obtained.

There remain "population samples" as recorded by the returns of adult beetles collected each year. Again, it is recognised that the collection of beetles is not a standard process each year. Planters are enthusiastic some years, and indifferent in others; areas in which beetles are plentiful and easy to collect in some years, and *vice versa* are the reverse in subsequent years. Nevertheless hand collection of beetles has been fairly well organised and by no means haphazard, during the period for which figures are given.

The figures are as below:

TABLE I.

Year	Total root borer adults reported collected.	Peak collections.	*Diaprepes* egg masses reported collected	Total brown hard back reported collected	Peak collections
1929	4,800,000	—	—	—	—
1930	6,300,000	June to August	Over ¼ million	—	—
1931	8,000,000	June and July	Hundreds of thousands	1,226,800	June.
1932	2,250,000	July and August	Several thousands	1,275,553	November.
1933	2,360,000	July and August	Several thousands	4,700,000	May to July.
1934	2,300,000	August to November	—	5,400,000	May and June.
1935	3,200,000	August	—	2,600,000	May and June.
1936	3,100,000	July and August	—	8,300,000	June to October.
1937	2,000,000	May, Aug. & Sept.	—	5,800,000	May to September.
1938	1,400,000	August & September.	—	6,600,000	August to October.

When considering these figures it must be borne in mind that, with a few exceptions, planters were willing to collect beetles; that collections were organised (described later), that the type of country and of cultivation in small fields (average 5 to 6 acres) is suitable for collections: the beetles are easily seen, and at night time, when collections by lamps take place, do not readily fly, and that a dense agricultural population per square mile is available for intensive collections.

Collections take place at night so as to obtain both root borer and brown hard back beetles. Root borers can be collected by day if desired, but brown hard backs cannot, because they hide in the soil in the day. Further, pigeon pea bushes which are planted round the borders of cane fields, serve not only as a valuable source of human food, but serve to attract large numbers of adult root borer beetles from inside the six acre fields.

The maximum efforts in hand collecting were made in 1929, 1930 and)31, particular attention being paid to root borers and their egg masses. This evident from the Table given above.

Subsequently, according to the figures, the comparatively easily collected *iaprepes* (which school children can collect in the day and so earn ready ush) were either neglected and despised, although paid for at a higher rate. ıd brown hard backs at a lower price were diligently sought after, or *Dia-repes* was definitely reduced in numbers and hard to find.

In the writer's opinion, the rise in brown hard back collections from 1933 awards, is not due to any alarming increase in their numbers, but because, in efault of root borer, they provided the ready cash for collectors, and therefore ow form the bulk of collections.

It is more difficult to reduce brown hard back population because, as stated. ıey have more alternate hosts and also their eggs cannot be destroyed, as were ıose of *Diaprepes* from 1930-33. Many planters collected and destroyed *Dia-repes* egg masses, but did not report numbers destroyed because the organisa-ion cards distributed to them did not call for such records; hence the numbers estroyed are probably far in excess of those recorded in Table I.

A final analysis of the figures is that, in 1938, the Government paid a *roportion* of the expenses of beetle collection for each estate and peasant pro-rietor and the collections made were island wide and well organised and dvertised.

It is presumed therefore that if more *Diaprepes* beetles could have been *asily* found, they would have been brought in to get the Government subsidy.

There are therefore the facts of increased ratooning and decreased root orer collections (the major pest) in support of economic control of cane root ests. To this can be added the increased tonnage of sugar during the past 10 ears, which should follow the economic control of insect pests.

It is certainly true that five other factors contribute to the increased ton-ıage, namely, increased rainfall over the last 10 years compared with the previ-us 10 years ; improved factories, new cane varieties, better manurial practices, nd control of the small moth borer *Diatraea saccharalis*. Nevertheless, when t is realised that the *average* increase of sugar production for each of the last 0 years is 34,210 tons of sugar per year there is scope for credit to be given o all, and part of the increase is considered attributable to control of). *abbreviatus* and *L. smithi*.

CONTROL MEASURES AGAINST D. ABBREVIATUS AND L. SMITHI.

So far only one control measure has been mentioned, namely hand collect-ng the adult beetles. This is only part of the picture, for the regular control ıeasures advocated to the planters by public lectures, the Press, Departmental Circulars, and private interviews are destruction of larval and pupal forms n the soil by digging up and splitting open cane stumps, ploughing the fields lateral soil pressure in ploughing will damage grubs sufficiently badly to ill a large proportion as well as killing those directly turned up for blackbirds o eat), and crop rotation in infested fields.

In addition there has been a considerable introduction and rearing of para-ites against both *D. abbreviatus* and *L. smithi* : see Jl. Agri. Dept., Barbados. Vol. 5 No. 1 (15) but none of these parasites has succeeded in establishing tself, though a predator introduced from Puerto Rico of the larvae of *L. smithi* ıas maintained itself in a localised area of the wetter, hillier regions of Barba-los for a period of four years. Its effect as a control of brown hard back is ıowever, not yet definite. The artificial rearing of the giant toad *Bufo marinus*

is also advocated as a control over *L. smithi* but few planters so far have built artificial pools, mosquito controlled, for rearing this useful insect predator. The rearing of *Bufo marinus* will be discussed in a separate paper.

The introduction, laboratory rearing, and liberation of tens of thousands of egg parasite *Tetrastichus haitiensis* and of *D. abbreviatius* has been discussed in (15), together with the rearing and liberation of various Scoliid wasps from Puerto Rico, and the mass introduction of the predator *Pyrophorous luminosus*. It is only necessary to mention here that no possible method of replacing and avoiding hand collecting of beetles has been neglected.

In addition to parasite introduction, large scale experiments in randomised plots were carried out with soil fumigants and contact insecticides in order to test the possibilities of soil treatments.

The following nine treatments were made in randomised plots in blocks with controls, in two areas of the island :—

(1) Carbon bisulphide emulsion.
(2) Kerosene emulsion.
(3) Carbolic emulsion.
(4) Kerosene and carbolic emulsion.
(5) Spraying oil emulsion.
(6) The foregoing plus crude carbolic acid.
(7) Calcium cyanide.
(8) Sodium cyanide solution, and
(9) Carbon bisulphide.

In the first place it was found that the labour entailed, and the supervision required especially in the handling of poisons, was beyond ordinary plantation capabilities. Secondly, the cost per acre was prohibitive. Thirdly, no kill reached even 50% of the total root borer and brown hard back grubs in any cane hole and less still in cane banks.

If a 100% kill had been secured in any case, then further investigations would have been undertaken to overcome the labour question and to reduce cost per acre.

However, proof was obtained of the fact that the soils of Barbados are too heavy and impervious to warrant soil treatments.

The final result has been a return to the apparently inescapable fact that control of root borer and brown hard back depends upon (a) hand collection of adults and egg masses in cane fields and (b) cultural methods.

Control by hand collecting has been placed first, because it is the method which comes in for most controversy and is the source of annual agitation in Barbados.

Actually, cultural methods are carried out by all planters, even those who profess to take no measures against either pest, and it seems reasonable that if the destruction of larvae in the soil was carried out efficiently the pests would be kept under control—always remembering the practically unique conditions of cultivation in Barbados.

Unfortunately, for various reasons, destruction of grubs in the soil is not entirely efficient, even under the intensive cultivation in Barbados.

Hand collecting therefore still remains a supplementary control measure.

HAND COLLECTING ADULT DIAPREPES ABBREVIATUS AND LACHNOSTERNA SMITHI.

That this is a controversial matter, the writer is well aware. The arguments against it are that it is (a) ineffective (b) a waste of time (c) very expensive (d) can be replaced by spraying (e) in some cases maintains rather than decreases infestation (14). Additional ones supplied by Barbados are

(f) that the man who collects is penalised because he has to pay for beetles from the estates of those who do not collect (g) that it cannot be effective without compulsion, either in the form of legislation enforcing collection, or a cess on land to pay for all beetles collected.

Taking each argument separately. The question of effectiveness depends upon the conditions under which hand collecting is practised, such as area involved, total area under crop to be protected and under forest, bush, or waste land, number and extent of alternate host plants, chances of re-infestaton and available labour supply. These points have been dealt with in previous pages and figures showing effectiveness of hand collection tabulated. The question of waste of time depends entirely upon effectiveness, cost, and alternate control methods. In Barbados it cannot be held to be a waste of time, as it is effective, economic and there is no known alternative. The question of expense is important. Judgments based on other pests, other conditions, other crops, etc. do not apparently apply in Barbados. It can be stated from reliable records of hand collecting root borer beetles and brown hard back beetles, under organised supervision in Barbados, that the cost of collecting over 1½ million root borer and brown hard back beetles in one year on one estate worked out at $2.97 (just under 12/6) per arable acre. This was paying 32 cents (1/4.) per 600 root borer beetles and 24 cents (1/-) per 600 brown hard back beetles (600 beetles fill a pint measure). The records, which extend over nine years show the cost of $2.97 per arable acre to be the highest: the lowest figure was 88 cents or 3/8 per arable acre. The figure in each case is for the entire year and depends naturally upon the number of beetles collected and paid for.

The average figure for 9 years records is $1.72 or 7/2 per arable acre per year. In the records analysed the price paid for the beetles sets a high standard of fairness.

The cost of hand picking as vouched for above, cannot be regarded as high, and economic results on the estate quoted are, in the writer's opinion, definite.

The objection that hand collecting can more economically and efficiently be replaced by spraying can definitely be refuted for Barbados. Cane fields cannot be sprayed. The pigeon pea bushes around them could be sprayed, but apart from the fact that the planting community in Barbados will not spray far more valuable crops than pigeon pea bushes, the spraying, if done, would not be effective against root borer beetles because they are known to avoid eating poison sprayed vegetation. Brown hard back beetles might possibly be killed by poison spraying but it is not an economic proposition in view of their diverse feeding range.

The objection that hand picking may actually maintain infestation at a high level is put forward by Le Pelley in (14) and is apparently based on pest and host plant and environment conditions which bear no relation to the problem of root borer in Barbados.

Some people in Barbados do, however, think that by planting pea bushes round cane fields they thereby induce root borer infestation. For this reason, and because the pea bushes may sap the vigour of adjacent head row canes, which may also show signs of root borer damage if the beetles which congregate on the bushes are not collected many planters dig up existing pea bushes and refuse to plant any at all.

The facts are that the pea bushes, by attracting the beetles from inside the canefields, make them much easier to collect and are also a handy "indicator" of local infestations; they cannot possibly "create" infestations.

The planting of pea bushes is therefore advised, provided the beetles they attract are regularly collected.

The remaining objections which are considered as local objections, are nevertheless very real. Hand collecting can operate very unfairly if some people

will not collect beetles with the result that neighbouring estates (which are continuous and demarcated only by estate plans) may have to collect or to pay for, beetles which do not come from their own fields.

Neither legislation, nor any form of financial compulsion is favoured at present, but, having reduced the more dangerous root borer to a low population level, it is hoped to keep it so by a maintenance of an organised voluntary system, possibly aided by grants towards defraying a part of the cost of collection.

The organised voluntary system in Barbados is, briefly, as follows.

The island is divided into areas of approximately 1,000 arable acres comprised of units formed by plantations. An owner or manager of one plantation in the unit or group is asked to act as an Honorary Secretary to the group. Printed cards are supplied by the Department, on which the data required by the Department can be supplied.

Each plantation sends its collections of beetles to the Honorary Secretary of the group for checking up and for payment of any Government subsidy. The cards recording numbers of beetles collected are also received, checked and sent into the Department by the Honorary Secretary. The position of Honorary Secretary is no sinecure and it speaks well for the willingness and public spirit of planters that the work, often unpleasant, has been carried out.

The price paid for beetles, which are measured per pint containing approximately 600 beetles is supposed to be fixed, but in practice some plantations or groups where beetles are scarce will raise the price, and others where there may be a temporary abundance of beetles (especially of hard backs, which tend to swarm) may lower the price. Neither practice is commended. If beetles are so scarce that collectors cannot find them in quantities worth their time and labour then that area can congratulate itself, and its negative records are of considerable importance to the Department. If on the other hand, there is an abundance of beetles, the price should not be lowered, because eventually the beetle pickers do not find enough to pay them at the low price, and cease picking when there is still a large enough population in that area to cause damage both there and elsewhere in succeeding years; at a normal price they would have continued picking.

Nevertheless, the organised voluntary system has worked reasonably well, and its continuance at fixed prices per pint of beetles is recommended, aided if necessary by a limited Government grant in partial payment of the certified collections of each estate.

SUMMARY.

1. *Diaprepes abbreviatus* and *Lachnosterna* (*Phytalus*) *smithi* can cause serious damage, if unchecked, to cane.
   The life history and habits of each pest has been worked out and published by other writers. The present paper recapitulates essentials.

2. The "Island garden" conditions of cane cultivation in Barbados, and the absence of any numbers or quantities of alternate breeding grounds are described, to indicate the fact that both pests are, to all intents and purposes, specific to sugar cane in Barbados.

3. The methods of control are given as soil cultural methods namely digging up and splitting cane stumps, ploughing and forking fields, aided by hand collecting or picking adult beetles especially upon a trap crop planted round cane fields of which the average size in Barbados is 5 to 6 acres.

4. The results of hand collecting the beetles is summarised over a period of ten years. Definite results are indicated, and the cost of beetle picking is given per arable acre. The method is shown to be economic.

5. The attempts to replace existing control measures by introduced parasites are summarised.

6. The method of hand collecting or picking is discussed in the light of a tendency to criticise it as ineffective and expensive or impracticable and it is shown that for the unique conditions of environment, single crop, lack of alternate hosts or breeding grounds, density of population, intensive cultivation, and absence of any alternate methods in Barbados, the control measures advocated including hand picking and artificial mosquito controlled ponds for rearing *Bufo marinus*, should be maintained.

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SECTION I.

GENERAL AGRICULTURE.

1. Weather Conditions During the Year.

Detailed climatic data are given in Appendix I to this report. The most important feature—rainfall, is considered here. The monthly rainfall affecting the 1939 sugar cane crop is given below and compared with the average of the same period 1920-38.

Month	Rainfall in Inches.	
	1920-38	1938-39
January	3.37	3.26
February	1.89	2.49
March	1.59	2.02
April	1.64	1.19
May	1.99	3.46
June	4.47	4.37
July	6.42	6.79
August	6.33	8.81
September ..	7.40	10.58
October	7.53	10.42
November ..	9.57	28.09
December ..	4.17	6.89
January	3.37	2.27
Total	59.74	90.64

It is seen that the dry season which was of comparatively short duration was followed by a long rainy season. The rainfall in November was the highest ever recorded in Barbados and caused marked soil erosion in sloping red soils and in the Scotland district.

As a result of the good rainfall the sugar cane crop made excellent growth and, although actual crop sugar yields are not yet fully available, it is certain that the crop will be a record one.

Ground provisions also benefited by the high rainfall but cotton was adversely affected. The cotton plants were stunted and bud and particularly boll shedding was very marked. The cotton yields will be low. Vegetable growing during the rainy season was made difficult on account of the high September-November rains. The seedlings were washed out of the ground before becoming properly established and even established plants were partially destroyed. This was especially so with vegetables such as tomato, stringless beans, carrots and beet of which there ensued a definite shortage. Bulbous plants such as eschalots were not so badly damaged. Rotting was very prevalent in the fruits and stems of cucurbits. It was evident that much of this rain damage could have been avoided by a soil protective mulch and it is hoped that surface mulching in future will be done by vegetable growers.

II. Agricultural Crops.

A. SUGAR CANE.

(1) *Production*:

During the 1938 crop season, there were 86,370 tons of sugar made by the vacuum pan factories, 2,748 tons of muscovado sugar and 7,357,923 gallons of fancy molasses which at the rate of 330 wine gallons to the ton of sugar may be equated as the equivalent of 22,296 tons of sugar. The total crop reaped in 1938, therefore, amounted to the equivalent of 111,414 tons. The smallness of the crop was due to the poor growing conditions of 1937 particulars of which were given in last year's report.

The crop to be reaped in 1939 which will be reported on more fully in the next annual report is estimated to reach the equivalent of 157,000 tons of sugar.

The sugar production in Barbados for the past five years is set out in Table I.

TABLE I.

Sugar Production for the Period 1934-39.

	1934	1935	1936	1937	1938	1939
Dark Crystal Sugar ..	79,321	44,138	102,085	105,036	86,370	133,296
Muscovado Sugar ..	3,613	2,273	3,176	3,228	2,748	2,961
Fancy Molasses	28,500	35,076	23,995	19,975	22,296	20,095
Total ..	111,434	81,487	129,256	128,239	111,414	156,352

(2) *Exports of Sugar and Local Consumption*:

During the first quota year of the International Sugar Agreement, i.e., from 1st of September 1937 until the 31st of August 1938, the net exports of sugar chargeable against the quota amounted to the equivalent of 102,922 tons which left a shortfall of approximately 10,606 tons sugar on the export quota of 114,000 allotted to Barbados. Although Barbados was short of its quota by this amount there was actually the equivalent of 12,500

tons of sugar as fancy molasses in the island awaiting shipment at the beginning of the next quota year. This fancy molasses although produced and sold for export during the crop season has to be stored in Barbados until required for consumption in Canada or the United States of America.

The difference between production and exports after allowing for the carry over of fancy molasses may be considered equivalent to the amount of sugar consumed locally and this works out at 8,444 tons for the year under review.

As already indicated, climatic conditions during 1938 were excellent and it is estimated that a record crop equivalent to 157,000 tons sugar will be reaped. Hence the amount of sugar to be exported in 1939 will be far in excess of the quota of 109,200 tons allotted to Barbados for export during the second year of the International Sugar Agreement. It is estimated that with the stocks of fancy molasses carried forward into this quota year the equivalent of over 50,000 tons sugar will have to be exported after the 1st of September unless the present export quota is increased.

The Legislature passed during the year an Act to make provision for the control of the manufacture and export of sugar made in the island; this Act establishes a Sugar Production and Export Control Board under the chairmanship of the Director of Agriculture. Each factory has been allocated the amount of sugar which may be manufactured for export in the quota year and export permits are granted by the Governor-in-Executive Committee for the export of such sugar.

(3) *Acreage under Cane*:

Under the Sugar Cane Census Act, 1937-31, it is now compulsory for all land-holders with more than ten acres of arable land to make a return to the Department of Agriculture, showing the number of acres of cane to be reaped during the ensuing crop season.

The result of this census for the 1938 crop is presented in Table II together with the corresponding figures for the 1937 and 1938 crops.

As a result of recent surveys made by the Peasants' Agricultural Instructors, the estimated small-holders' acreage has been in all cases increased from 3,750 to 7,000 acres. The acreage for 1939 is seen to be greater than those of 1938 and 1937 by approximately 1,200 and 2,200 acres respectively. Actually the 1939 plant cane acreage shows a decrease from the other years but this is more than offset by the acreage which has been kept under ratoons.

TABLE II.

Acreage of Sugar Cane Reaped in 1937, 1938 *and* 1939

Year	ACREAGES.							
	PLANTATIONS.							
	Plant canes	First ratoons	Second ratoons	Third ratoons	Fourth ratoons	Fifth ratoons	Small holders Estimated	Total
1937	16,919	10,661	3,864	722	85	10	7,000	39,261
1938	16,642	11,239	4,559	800	131	—	7,000	40,371
1939	16,571	11,507	5,337	995	122	—	7,000	41,532

(4) *Yield of Cane and Sugar*:

Since this report is compiled about half way during the crop, it is not possible to give cane and sugar yields. It is evident, at the time of writing, that the 1939 crop will be a record with regard to yield of cane and sugar. As usual the detailed variety and sugar yields will be published later in a separate report.

(5) *Variety Acreages*:

These were obtained from plantation returns of the variety acreages to be reaped in the 1939 crop. They are presented in Table III and the variety percentages for all crops in 1938 are inserted for comparison.

TABLE III.

Acreages of Sugar Cane Varieties Recommended by the Department, and other Varieties reaped in 1939 *and* 1938.

Variety	Plant canes	First ratoons	Second ratoons	Other ratoons	Total	Percentage of Total	
						1939	1938
B.2935	9,215.97	4,273.13	939.25	108.75	14,537.10	42.10	39.30
B.H.10 (12)	2,732.00	2,986.70	2,543.50	706.75	8,968.95	25.97	27.23
B.726	2,672.75	3,043.80	1,604.25	268.00	7,588.80	21.98	26.74
B.3013	1,389.00	907.50	112.25	—	2,408.75	6.98	3.82
B.3127	287.00	18.00	.50	—	305.50	.88	—
Other & mixed varieties	274.28	278.00	137.25	33.50	723.03	2.09	2.91

It is seen that the percentage of B.2935 has slightly increased, and that of B.3013 has increased appreciably. B.3127 acreage has increased sufficiently to warrant its separate inclusion. The percentage acreages of B.H.10(12) and more especially B.726 have dropped.

It may safely be said that B.2935 has displaced part of the B.726 acreage while B.3013 and B.3127 have displaced in part both B.726 and B.H.10(12) Both these newer seedlings are particularly strong ratooning canes with high juice quality, B.3013 being especially adapted to the better class red soils while B.3127 has particular value in poorer red soils and in intermediate rainfall districts.

From the individual returns received it is evident that plantations plant varieties in close accord with the recommendations of the Department.

(6) ***Fancy Molasses***:

The Barbados fancy molasses industry **has continued** to be **under the control of the** Fancy Molasses Control and Marketing Board of which the Director

of Agriculture is Chairman and it is generally agreed that this measure has had a far-reaching effect in stabilizing the industry. The fancy molasses market was somewhat disorganised in 1938 owing to the passing of a new Sugar Act in the United States of America dated September 1937. In addition, the demand for fancy molasses in Canada did not reach expectations and, although at the beginning of the year, the requirements of the market were estimated at 75,000 puncheons only 66,890 puncheons were actually produced and, of this amount, 5,969 puncheons remained unsold in Barbados at the end of December 1938.

For the year 1939, the Fancy Molasses Board has allocated for production 61,270 puncheons which, with the carry over from the previous year, will permit of exports equivalent to 67,426 puncheons.

B. COTTON.

During the year under review, only seventy-seven acres of cotton were grown commercially. Two estates in St. Philip grew approximately twenty acres and the remaining acreage was grown by small holders in the drier parishes.

No precautions were taken to prevent defoliation by *Aletia* and the crops on both estates and some small holdings were completely stripped of leaves at a critical stage in growth. This factor coupled with an excessive November rainfall resulted in the majority of cases in very poor yields. Excellent plots of small holders were seen occasionally.

Progeny row and bulking plots and a variety trial were grown by the Department. On account of excessive rains, yields from these were poor.

Cotton crops were periodically inspected to note the pink bollworm situation. Pink bollworm was seen at two places only and at those, near the end of the crop. It would appear that the enforced close season from March, 1937, to September, 1938, has had a beneficial effect.

C. MINOR CROPS.

Elsewhere in this report it will be seen that the work under this head is developing rapidly.

Fruit Trees:

A critical selection of local and, in some cases, imported varieties of citrus, avocado pear, mango and breadfruit is being made and the selected varieties being propagated for distribution. Special mention should be made of the selection of pear and breadfruit varieties which appear inherently to possess the characteristic of bearing fruit out of the accepted season. The importance of propagating and distributing such types is evident.

Ground Provisions and Pulses:

Experiments are being conducted with imported varieties of ground provisions and pulses. Under this head attention is drawn to the success of the tepary bean imported from Northern Rhodesia. This plant in tests gave unusually rapid and high yields of very palatable beans.

During 1938, voluntary returns were made by plantations representative of 84.4 per cent. of the arable acreage to show the area under ground provisions. A summary of the position is given in Table IV. It may be noted that the area planted was greater than in 1937 and this is probably mainly due to the better weather conditions.

Total arable acres from which returns were received	Sweet potatoes	Yams	Eddoes	Maize	Black eye peas	Cassava	Tomatoes and bananas	Per cent acres under food crop of arable acres returned
43,908	1,223	971	458	737	181	31	66	8.3

Vegetables:
In the vegetable experiment section the successes of the mildew resistant cantaloupe No. 45 and an okra variety imported from India are noteworthy. The results of tests with vegetable seeds imported from two Indian commercial firms are awaited with interest.

Soya Beans:
It would appear tbat, unless strains of soya beans suited to the tropics are evolved, there is little hope of growing this crop commercially in Barbados.

Arrowroot:
The Arrowroot Growers' Association has continued to work the co-operative factory again this year and excellent yields of roots are reported. Manurial trials are being reaped and results of these will be published when completed. In the Chalky Mount district there seems little doubt that arrowroot is a more profitable crop than sugar cane.

Ginger:
Samples of locally grown yellow ginger have been sent both to England and the United States of America for market reports and, if remunerative prices can be obtained, ginger will be encouraged as a small holder's cash crop.

III. Pests And Diseases.

PESTS.

1. SUGAR CANE:

(a) *Small Moth Borer of Sugar Cane (Diatraea saccharalis).*
The liberation of the mass reared egg parasite, *Trichogramma minutum*, as a control of this pest was continued during the year. The total number of these parasites liberated amounted to 308 million which is about 100% greater than the average of the previous five years. A review of this method of control over the past nine years is given in the entomological section of this report.

During the year, Government voted funds to provide for the introduction from Brazil of a melanic dry area race of *Metagonystylum minense*, a larval parasite of *Diatraea*. Details of this introduction will be given in next year's report.

(b) *Root Borer* (*Diaprepes abbreviatus*) and Brown Hardback (*Lachnosterna smithi*).
A Government grant of £250 was made towards the cost incurred by plantations in paying for beetles collected during the year under review. Planta-

tions were organised in districts with local secretaries so as to ensure full co-operation and general collection, and it is pleasing to record that the organisation proved most successful. The number of beetles collected was much smaller than anticipated.

2. COTTON:

(a) *Pink Bollworm* (*Platyedra gossypiella*).

There was only a small acreage of cotton grown during the year under review but although the cotton was periodically inspected, pink bollworm was only found in two fields of cotton in the parish of St. Michael. The amount of infestation was very small and the date of discovery was March 6, or almost at the end of the growing season. It would appear that the eighteen months close season of the previous year had a beneficial effect although climatic conditions may also have been a contributing factor.

(b) *Cotton Leaf Defoliator* (*Aletia argillacea*).

This pest made its appearance in the latter months of 1938 and on two plantation fields caused almost complete defoliation during the Christmas holidays. This pest can be adequately controlled by spraying with lead arsenate or dusting with Paris green and lime.

Rats.

Large scale distributions of baits poisoned with Thallium sulphate were made to plantations during 1938 in conjunction with the Agricultural Society. The cost of these baits was lowered by a grant of £250 from Government. Circular letters were later sent to plantations for reports on the efficiency of these baits and approval was universal.

Wood Ants.

A Wood Ant Inspector is now employed by Government to inspect and report on damage by wood ants to Government buildings. Private individuals have been enabled to make use of the services of the Inspector on payment of a fee.

DISEASES.

No new diseases of the chief agricultural crops have been reported.

Mosaic Disease:

Mosaic disease of sugar cane is still effectively controlled by a system of Government inspection, eradication of diseased stools and distribution of clean planting material to peasants in proclaimed areas. The newer seedling—B.35187—in addition to remaining free from mosaic in mosaic resistance tests and in small holdings in proclaimed areas, is also giving unusually high cane yields in the intermediate and high rainfall areas and has every promise of becoming an established commercial variety.

Gumming Disease:

Gumming disease of sugar cane is present to a negligible extent on account of growing resistant varieties.

Seed Borne Diseases :

Throughout the season, cases of diseases of temperate country vegetables grown in the island from imported seed have been examined and control measures recommended. Since the majority of these diseases are seed-borne and therefore imported, it would appear desirable to evolve some system to exclude

or greatly lessen their importation. One obvious way of achieving this, at least in part, would be by importation of seed from reputable temperate country seed firms and growers are urged to deal with firms recommended by the Department.

The Department is constantly endeavouring by tests to obtain and recommend varieties of vegetables which are resistant to the commoner and more destructive diseases e.g. mildew of muskmelons, mosaic and rust of stringless beans and bean blight.

IV. Peasant Agriculture.

During the year under review, a second Peasants' Agricultural Instructor has been added to the staff of the Department. This Instructor has been stationed in the parish of St. James and will be responsible for peasant instruction in the parishes of St. Lucy, St. Peter, and St. James. The Senior Peasants' Instructor is stationed in St. Joseph and is at present responsible for the instruction of small holders in the other parishes. As this is an almost impossible task it is hoped that a Third Instructor will be appointed for the parishes of Christ Church, St. Philip and St. Michael.

An account of the detailed activities of the Peasants' Agricultural Instructors may be found later in this report.

The policy which is being adopted in the department of peasant agriculture may be summarised under the following heads:—

(a) *Educational*: A course of lectures was given to elementary school teachers by the staff of the Department during the summer vacation and every encouragement is given to schools to develop school gardens. Visits and lectures have been given to peasants by the Instructors and, in addition to general agricultural advice on crops, practical demonstrations are given of spraying to control insect pests, of plant propagation etc.

(b) *Extension and Improvement of Crops*: The extension of fruit culture is encouraged by the propagation and distribution of good quality citrus, mango, avocado pear, breadfruit, guava and coconuts. From the results of variety trials, the best planting material of sugar cane varieties, sweet potatoes, onion, cantaloupe melon, squash, cucumber, sorrel, pigeon peas, okras, eschalot, tomato, cauliflower, cabbage pumpkin, Indian and guinea corn, bonavist, bush tepary and lima beans and fodder canes are being distributed.

The small holders are becoming more and more appreciative of the work which the Department is carrying out on their behalf and already it is evident that the general standard of peasant agriculture has considerably improved.

V. Land Settlement.

In 1938, the Barbados Government purchased the Vieux Fort Estate and Sugar Factory in St. Lucia for the purpose of land settlement. The property consists of a total acreage of about 4,000 acres of which about 2,500 acres are arable. The scheme is being carried out under the aegis of a Joint Stock Company of which the shares are held by the Governor-in-Executive Committee. The Board of Directors which consists of five members is appointed by the Governor-in-Executive Committee and, according to the Articles of Association, two of the Directors shall be persons who are members of the General Assembly of the Island of Barbados and one of the Directors shall be a member of the Legislative Council of the Island of Barbados. The Director of Agriculture

was appointed a Director of the Company by the Governor-in-Executive Committee and at the first meeting of the Board, was elected Chairman.

The first financial year of the Barbados Settlement Company will end on the 30th of June 1939 and, when the accounts have been audited, a full report on the progress of the Company to that date together with an audited statement of accounts will be printed for general circulation.

The Company took over the Vieux Fort property in May 1938 and found it in a derelict condition. It was decided to keep about 325 acres of ratoons which were covered down with weeds and bush and most of the drains in these fields required re-making. In addition, about 400 acres of old cane land were brought back into cultivation and planted with cane which will be reaped in 1940.

The settlement part of the scheme could not be immediately proceeded with for a number of reasons chief amongst which were the presence of two swamps which were a source of mosquitoes and malaria and there was no internal survey of the estate available. The Barbados Legislature had decided that no settlers should be sent until these swamps had been drained. The Tourney swamp on land of the Company has been canalised and planted in sugar cane. This drainage scheme has been a success and it is reported that mosquitoes have largely disappeared in Vieux Fort Village since this work has been completed. The Pointe Sable Swamp is partly on land not under the control of the Company but the Company has obtained an option to purchase this portion of the swamp. The Barbados Legislature considers that half the cost of draining this swamp should be borne by the Government of St. Lucia.

In order to facilitate the land settlement part of the scheme, the Barbados Legislature has recently agreed that settlers may be sent to St. Lucia before the drainage of the Pointe Sable swamp and arrangements are being made to erect houses and lay out small holdings comprising four acres of arable land on the Beau Sejour estate so that between 25 and 50 families may be settled later in 1939.

A serious drawback to the scheme is that a quota of only 2,000 tons of sugar has been allotted to Vieux Fort Factory. Since there is approximately 2,500 arable acres available on the property it is evident that when the estate is fully settled it will be possible to produce between 5,000 and 6,000 tons of sugar. It is essential that the small holders should be able to produce a remunerative cash crop if they are to be able to pay for their houses and land. In 1938, the factory made slightly more than 700 tons of sugar at an average recovery of 9.13 tons of cane per ton of sugar. This recovery must be regarded as very satisfactory since a good many acres of cane were fourth and fifth ratoons and of the variety Co.213 and the factory is by no means an efficient one. In 1940, there will be 400 acres of plant cane and about 200 acres of ratoons to reap and it is estimated that the crop will reach between 1,600 and 1,800 tons of sugar.

VI. Seed And Plant Distribution.

1. CODRINGTON BOTANIC STATION.

(a) *Propagation and Distribution of Ornamental Plants.*

These were distributed free or at a nominal cost during Arbor Week, and also throughout the year at slightly higher costs. These distributions are summarised below:

TABLE V.

Period.	Number of orders	No. of species distributed	No. of plants distributed
(1) During Arbor week (August 8—13) ..	335	68	10,511
(2) During the year and excluding Arbor Week	300	66	3,400

These figures constitute a record for numbers of orders, species and plants distributed.

In addition to these growing plants distributed, seeds of several ornamental plants were also given out.

(*b*) *Distribution of Useful Plants.*

This aspect of the work of the Botanic Station has been greatly expanded, particularly in regard to citrus, mango, avocado pear and breadfruit.

During the year, 850 orders for useful plants were received and the distributions made are set out in Table VI.

TABLE VI.

Species.	Total No. of Plants delivered.	Varieties.
Breadfruit	42	Yellow flesh.
Ficus carica (Fig)	37	
Grapefruit	133	Foster, Duncan, Marsh, Walters, Layne House No. 1, Layne House No. 2, Claybury No. 1.
Guava	60	French and Common.
Lime	193	Codrington and Lisbon.
Lemon	32	Rough.
Mandarin	15	Layne House No. 1, Layne House No. 2, Alleyne View, Claybury.
Mango	540	Julie, Devine, Dora Barbadensis, Pere Louis, Dr. Rowland.
Orange	162	Tardiff, Parson Brown, Navel, Layne House No. 1, Layne House No. 2, Layne House No. 3, Church Village, Brooks, Wilkie, Lue Gim Gong, Cocoa, King, Ruby.
Pear	75	Claybury Nos. 1, 2 and 3, Wheelers, Arthur Nos. 1 and 2, Codrington, Francia, Stepney, Major Lenigen, Maqueripe No. 2, Frere Pilgrim Nos. 1, 2 and 3.
Pomelo	14	Codrington and Hill View.
Shaddock	30	Burke's Village, Sarjeant, Claybury Nos. 1 and 2, McClure, Layne House No. 1.
Citron	5	Trinidad.
Total	1,338	

(*c*) *Establishment of Orchards to Supply Seed or Scion Material.*

Great progress in this sphere was made. A summary of the specially selected economic trees planted in orchards in the Botanic Station is given in Table VII.

TABLE VII.

Species	Number of varieties	Number of trees established
Mango	5	6
Avocado Pear	29	30
Orange	13	15
Grapefruit	8	9
Lime	4	7
Pomelo	2	2
Shaddock	5	5
Citron	1	1
Mandarin	2	2
Sapodilla	1	1
Breadfruit	1	2
Fig	1	4
Coconut	2	18
Totals	74	102

2. CODRINGTON EXPERIMENT STATION:

The Field Station is used for the routine testing of sugar cane seedlings in their early stages, for cotton progeny row and initial bulking work and for testing minor field crops. These phases of the Experiment Station's activities are detailed later in this Report.

In addition to the above, distribution of planting material is done. This is summarized in Table VIII.

TABLE VIII.

Crop	No. of varieties distributed	Amount of material distributed.
Sugar Cane	6	43,850 cuttings
Sweet Potatoes	11	36,296 „
Guatemala Grass	1	7,762 „
Sweet Cassava	1	1,319 „
Banana	1	35 suckers
Eschalot	1	14½ pounds bulbs
Okra	4	20 ounces seed
Soya Bean	1	10 pounds seed
Tepary Bean	1	5 „ „
Vegetable Marrow ..	1	1 ounce „
Onion	2	2 ounces „
Squash	1	1 ounce „
Cucumber	1	1 „ „
Melon	1	1½ pounds seed
Dwarf Coconuts	1	3,156 nuts

The distribution of sugar cane comprised cuttings of the newer seedlings:—B.3127, B.3254, B.3439, B.35187, B.35245, B.37161.

3. DISTRIBUTION OF VEGETABLE SEEDS FROM THE DEPARTMENT OFFICES.

This distribution aims at encouraging the purchase of seed of vegetable varieties which have been shown by Department tests to be best suited to local conditions.

The Department purchases these seeds from reliable firms and sells in small quantities at cost price.

The distribution of seeds with amounts during the year is set out in Table IX.

TABLE IX.

Seed	Variety	Amount
		lb.
Beans	Bountiful	680
Beet	Eclipse	22
Cabbage	Danish Ball Head	4⅜
	Late Flat Dutch	2¾
	Succession	⅛
Carrot	Half Long Danvers	5¼
	Oxheart	4¼
	Chantenay	3⅝
Cauliflower	Early Patna	1
	Early Market	1
Lettuce	Mignonette	4¾
Tomato	Marglobe	3⅝

SECTION II.

(A) REPORT ON PLANT BREEDING AND SEEDLING TESTING.

— BY —

A. E. S. McINTOSH,

Assistant Director of Agriculture and Botanist.

I. SUGAR CANE.

- A. SUGAR CANE BREEDING, SEEDLING SELECTION AND TRIALS.
- B. SPECIAL INVESTIGATIONS.

II. COTTON.

III. MINOR CROPS.

- (i) ECONOMIC FRUIT TREES.
- (ii) GROUND PROVISIONS, PULSES, GRAINS.
- (iii) VEGETABLES.
- (iv) NUTS, OIL SEEDS.
- (v) MISCELLANEOUS.

I. SUGAR CANE.

A. Sugar Cane Breeding, Seedling Selection And Trials.

(*i*) SUGAR CANE BREEDING—B.41' SERIES.

The usual methods were employed in the controlled crossing at Lion Castle plantation during October—December 1938 and the ripened fuzz sown in boxes at Codrington Botanic Station.

The season was one of very heavy arrowing and resulted also in high germinations from the crosses.

The following table summarises the crosses, their germinations and pottings under group heads. Details will be given in the next number of the Agricultural Journal.

Group	No. crosses made	No. seedlings produced	No. potted
Noble crosses—*Saccharum officinarum*	18	18,097	9,852
Saccharum spontaneum			
(i) Celebes—3rd nobilisation	6	714	503
(ii) India —2nd " ...	3	1,545	1,192
(iii) Java —3rd "	8	1,783	1,353
—4th "	11	12,794	2,985
—5th "	12	2,130	1,217
Saccharum barberi —2nd "	1	62	48
—3rd "	2	937	725
Saccharum sinense —2nd "	3	78	57
Crosses involving several *Saccharum* species	14	5,192	3,267
Totals	78	43,270	21,151

The tendency now in breeding and potting is towards increasing the proportion *of seedlings of nobilised origin while decreasing that of seedlings* derived from noble parentage. This is being done on account of the extremely promising nature of nobilised seedling selections. It is anticipated that future work will develop this tendency.

In addition to the controlled crosses summarised above, a further trial of *the Hawaiian* breeding method was carried out with certain modifications in the technique, which were kindly supplied by Mr. A. J. Mangelsdorf, Geneticist of the Hawaiian Sugar Planters' Association.

Six crosses were made in a gully close to the breeding plots, but unfortunately the experiment was again a complete failure as the solution failed to keep the parent arrows alive for a sufficient length of time for flowering and maturation to take place.

(ii) PLANTING FIRST YEAR SEEDLING TRIAL—B.40′ SERIES.

This series was bred in 1937, planted in the field nursery in March—April 1938 and selections from the field nursery planted in the First Year Seedling Trial in October 1938. This trial will be reaped in 1940. A summary of the First Year Trial planting is given below:—

Type of Cross	No. of Croses	No. planted in First Year Trial October, 1938
Noble	7	3,540
Nobilisations.		
1. *Saccharum spontaneum* (Java)		
(a) 3rd degree	1	46
(b) 4th degree	5	897
(c) 5th degree	9	2,482
2. *Saccharum spontaneum* (India)		
(a) 2nd degree	1	258
3. *Saccharum spontaneum* (Celebes)		
(a) 3rd degree	1	49
4. *Saccharum spontaneum* (Java-India)		
(a) 4th degree	1	998
5. *Saccharum barberi.*		
(a) 2nd degree	2	191
(b) 3rd degree	1	49
6. *Saccharum sinense.*		
(a) 1st degree	2	7
(b) 2nd degree	1	1
7. Mixed Derivations	6	699
Total	37	9,217

(iii) SUGAR CANE SEEDLINGS—B.39′ SERIES.

These were planted from the field nursery in October—November, 1937, and are being reaped during the present crop. A detailed account of this reaping and selections therefrom will be published in the next issue of the Agricultural Journal.

(iv) FURTHER PROGRESS WITH FIRST YEAR TRIAL SELECTIONS—B.38′ SERIES.

This refers to progress made with seedlings selected as first year seedlings during the 1938 crop.

In all, 99 *noble-cane seedlings* were selected. These were multiplied at Codrington Experiment Station until November when all were planted in plots at Dodds; these plots to serve for multiplication and gumming disease resistance tests. The survivors from these tests will be planted in Second Year Trials during season 1939–41.

In addition to the above, 121 *nobilised* seedlings were selected. These were multiplied at Codrington Experiment Station during 1938 and in October, from these plots, 75 were selected and allocated to the Central Sugar Cane Breeding Station second year trial at Codrington for 1938—40, as follows:—(a) thick-cane trial (standards—B.2935 and P.O.J.2878)—43 seedlings and (b) thin-cane trial (standard—Co.213)—32 seedlings.

The 16 *early nobilisations* selected in 1938 were multiplied during the year and planted in November at Lion Castle to serve as parents in further nobilisation work.

(v) SECOND YEAR SEEDLING TRIALS—B.37′ SERIES.

Noble-cane Seedlings. These were selected from the First Year Seedling Trial in 1937. All were multiplied during 1937 at Codrington and in November of that year sent to Dodds for further multiplication, gumming disease resistance tests and minor selection.

Of the 112 seedlings, 56 were eliminated on account of poor appearance in the field or susceptibility to gumming disease. The remaining 56 were planted in the Second Year Trials for the season 1938–40,—22 being placed in the early group and 34 in the late group.

Nobilised Seedlings. These selections, made in the multiplication plots at Codrington Experiment Station in October, 1937, were tested in a special Central Sugar Cane Breeding Station second year trial at Codrington Experiment Station during season 1937–39. Selections on reaping were as follows:—

(a) Thick-cane trial—B.37′ series: standards B.2935 and P.O.J.2878. Out of 32 seedlings included in this trial 8 were selected.

(b) Thin-cane trial—B.37′ series: standard—Co.213.

Out of a total of 17 seedlings 10 were selected.

Selections from the above trials were allocated as follows (in a few cases selected seedlings were placed in more than one of the following categories):—

(i)	Select Seedling Trials, Barbados	6 seedlings
(ii)	Plant Quarantine Station, Trinidad, for trial in Other West Indian Islands	16 „
(iii)	Lion Castle for breeding work	18 „
(iv)	Mosaic Resistance Test	18 „

It may be mentioned here that some of the nobilised selections to be included in the Select Seedling Trials in Barbados during 1939–41 appear decidedly promising for Barbados conditions.

(vi) SELECT SEEDLING AND VARIETY TRIALS—B.31′, B.32′, B.33′, B.34′ AND B.35′ SERIES.

These constitute respectively the pen-ultimate and ultimate trials in the routine work of testing seedlings prior to making final recommendations on each. On account of many of these trials being in ratoon stages, it follows that seedlings originating in quite a number of years are included in them.

These trials are in the process of being reaped so that detailed results are held over until the next issue of the Agricultural Journal.

B. Special Investigations in Sugar Cane.

(i) GROWTH MEASUREMENTS.

During the season 1937–39, growth measurements were made in the following newer seedlings included in the plant cane Maturity Experiments:—B.3419, B.3464, B.3479, B.35187, B.35245. The standard varieties B.H.10(12) (high rainfall district), B.726 (high and low rainfall districts) and B.2935 (low rainfall district) were included and measured for purposes of growth comparisons.

Growth measurements were also carried out on the following seedlings and standard varieties in the first ratoon Maturity Experiment in the high rainfall district:—B.H.10(12), B.726, B.3013, B.3127, B.3439.

(ii) GUMMING DISEASE INVESTIGATIONS.

During the season 1937–39 a total of 173 seedlings were tested at Dodds for their resistance to gumming disease. Of these 112 were noble canes and were planted in twenty-four stool plots, and 61 were nobilisations which were planted in three stool plots. A summary of the results obtained is given below:—

	No gumming	Trace	Very slight	†	††	†††	††††	Total
Noble canes	39	16	12	19	12	12	2	112
Nobilisations	50	4	1	2	2	2	0	61

(iii) SUGAR CANE MOSAIC DISEASE RESISTANCE TEST.

Up to the time of writing this report, a total of 12 seedlings have been under test for mosaic disease resistance for a period of fifteen months and over without showing any symptoms of the disease, while 11 seedlings have been eliminated owing to their susceptibility.

Of the remaining 83 seedlings now included in the test, 2 have been in for a period of nine months and 8 for a period of three months, leaving 73 seedlings which were planted in March of this year when it was decided to extend the test in the hope that in time it would be possible to have included in the test all seedlings selected from the First Year Seedling Trial.

The last planted group of seedlings consists of 18 seedlings of the B.37′ series, which completes the number of this series to be tested, and 55 seedlings of the B.38′ series, leaving another 20 seedlings of this series still to be included in the test.

(iv) INVESTIGATIONS WITH THE ZEISS AND REFRACTOMETER AS AN INDICATOR OF RIPENING.

During 1935 and 1937 investigations were carried out on the use of the Zeiss Hand Refractometer as an indicator of ripening. Working on the hypothesis that ripeness is attained when the top/bottom refractometer solids ratio reaches unity, a study was made of the effects of season, place, cane age class and variety on ripening. These results have been published.*

In order to ascertain how far the top/bottom ratio hypothesis might be relied ou, a further investigation was undertaken and data was obtained at the reaping of the Maturity Experiments at the low and high rainfall stations in 1938. The results have been studied and will shortly he available in the form of a Bulletin. A summary of the results is given below:—

Using the same sampling technique as has been previously described,* top/bottom refractometer solids ratios were calculated for each seedling at each place and for each time of reaping. These ratios were in each case the quotient of the mean of the top readings divided by the averages of the middles and the bottoms. In addition sample bundles from each plot were sent to the laboratory, where they were divided into tops, middles and bottoms respectively and determinations of per cent. sucrose, per cent. glucose and degree brix made. These are now considered:—

1. *Zeiss Hand Refractometer Solids.* In every seedling and at both stations the refractometer solids increased steadily from the early reaping until the late reaping and as might be expected the increase was most marked in the top sections of the cane.
2. *Degree Brix.* This agreed closely with the hand refractometer determinations although in every case they were somewhat lower, the difference heing more marked in the top sections than in the middle and bottom sections.
3. *Per Cent. Sucrose.* As in 1 and 2 the per cent. sucrose increased steadily from the early until the late reaping in every case—the increase being most marked in the top sections.
4. *Per Cent. Glucose.* There was little variation in the per cent. glucose between the early and late reapings.
5. *Sucrose/Glucose Ratio.* At the low rainfall station there was little similarity between the four varieties, while at the high rainfall station there was a sharp rise in the sucrose/glucose ratio at the middle reaping followed by a sharp drop at the late reaping. This was the same for all four varieties.
6. *Top/Bottom Refractometer Solids Ratio.* At the low rainfall station the top/bottom refractometer solids ratio reached unity by the middle reaping in three out of the four seedlings, while the fourth reached unity at the late reaping. At the high rainfall station one seedling reached unity by the middle reaping and one at the late reaping; the other two seedlings failed to reach unity even at the late reaping.
7. At both stations, the weight of cane reaped tended, if anything, to rise or at worst to remain approximately the same over the three reapings. It is therefore extremely probable that the highest potential sugar yields were obtainable at the last reaping.

* McIntosh, A.E.S., and Stevenson, G. C.—June, 1938. B.W.I.C.S.C.B.S. Bull. 13. (3) The Zeiss Hand Refractometer as an Indicator of Ripening in Sugar Cane.

8. It seems reasonable to regard any variety at any one place as being at its peak of maturity during crop at the time when it is giving its highest sugar yields. In these tests this was at the late reaping.
9. It would thus appear that from the commercial viewpoint, criteria such as sucrose/glucose ratio and hand refractometer top/bottom solids ratio would actually be misleading.
10. Since, in all hand refractometer investigations, carried out in recent years in Barbados, it has been conclusively shown that, under Barbados conditions, there is a strong positive correlation between hand refractometer brixes and sucrose per cent. in juice and that the latter tends to improve throughout the course of the crop, the determination of the hand refractometer brixes coupled with cane weights of seedlings throughout crop is the most reliable means of assessing the comparative maturation rates of seedlings.
11. Maturity experiments, as conducted over the last ten years would appear to be the most satisfactory method of doing this.

II. COTTON.

PROGENY ROW WORK.

The seed cotton which was obtained from the progeny rows during the season 1937—38 was analysed in July, 1938, and the results are given in the following tables.

TABLE GIVING RESULTS OF ANALYSIS OF SEED COTTON FROM SELECTED PLANTS FROM PROGENY ROWS FOR SEASON 1937-38.

Plant.		Weight of seed cotton from 50 bolls in grms.	Weight of seed cotton per boll in grms.	Lint Index from 100 seeds of seed cotton grms.	Seed weight from 100 seeds of seed cotton in grms.	Ginning outturn.	Frequency arrangement of mean maximum lint length of 50 seeds in mm.														Mean lint length of 50 seeds mm.
							50	51	52	53	54	55	56	57	58	59	60	61	62	63	
B. 170—2	Row 1	175·0	3.50	4·34	12·80	25·3				1	2	12	10	14	7	4					56·4
	Row 2	182·0	3·64	5·72	11·38	33·5			2	1	1	20	9	8	2	4	3				56·1
	Row 3	168·0	3·36	5·38	11·66	31·6				3	3	13	18	3	5	5					56·0
	Row 4	161·0	3·22	4·85	11·25	30·1	2				12	17	12	4		1	2				55·2
B. 170—4	Row 1	196·0	3·92	4·68	12·18	27·8						1		9	12	13	8	5		2	58·8
	Row 2	161·0	3·22	4·25	12·39	25·5						7	11	16		10	4	1	1		57·3
	Row 3	168·0	3·36	4·98	11·62	30·0						8	6	6	11	6	11	2			57·8
	Row 4	161·0	3·22	4·19	12·35	24·7					2	7	8	5	14	5	7	2			57·5

TABLE GIVING RESULTS OF ANALYSIS OF BULK SAMPLES OF SEED COTTON FROM PROGENY ROWS FOR SEASON 1937—38.

Plants in Row.		Lint Index from 100 seeds of seed cotton grms.	Seed weight from 100 seeds of seed cotton in grms.	Ginning outturn.	Frequency arrangement of mean maximum lint length of 50 seeds in mm.											Mean lint length of 50 seeds mm.
					50	51	52	53	54	55	56	57	58	59	60	
B. 170—2	Row 1	5·36	12·78	29·5					2	14	13	4	8	7	2	56·6
	Row 2	5·44	11·26	31·9				1	5	20	13	8	2	1		56·0
	Row 3	5·15	11·92	30·2		1	2		7	18	10	8		4		55·5
	Row 4	5·70	12·22	31·8	2				9	14	21	2		1	1	55·3
B. 170—4	Row 1	4·55	11·41	28·5						7	10	12	6	8	7	57·5
	Row 2	4·63	10·96	29·7						3	11	11	9	4	12	57·5
	Row 3	4·55	11·40	28·5						2	12	10	10	7	7	57·4
	Row 4	4·67	10·96	29·9						10	16	6	4	7	7	57·1

During the season 1938—39, selfed seed from five selected plants of the two strains B.170 No. 2 and B.170 No. 4 was again planted in progeny rows at Codrington Experiment Station. Each strain was replicated twice, each replicate consisting of a row of 36 plants. One plant was selected in each row and the flowers selfed, the flowers on the remaining plants in each row also being selfed. The seed cotton from each selected plant was picked and bagged separately. Owing to the very unfavourable weather conditions which prevailed, it was not possible to obtain 50 selfed bolls from each plant for analysis as customary. The selfed bulk seed cotton from each row was bagged separately, and this seed will be grown to provide commercial planting material for the 1940—41 crop.

The analyses of the seed cotton from these progeny row selections have not yet been carried out.

Multiplication of Seed.

The selfed bulk seed obtained from the progeny rows in 1937—38 was planted at Codrington Experiment Station in September, 1938. The seed obtained from this crop will be distributed for commercial planting in September, 1939.

Variety Trial.

At the request of Mr. J. B. Hutchinson, M.A., Cotton Adviser to the Commissioner of Agriculture, a variety trial was carried out during the season 1938—39. Six varieties were tested, i.e., Barbados (commercial), St. Vincent—V.135, A.N. and B.D., Nevis and Montserrat. Results are not yet available for this Report as harvesting is not yet completed.

III. MINOR CROPS.

This section reports progress made in recently initiated schemes for extending the growth and improving the quality of existing minor crops and importing strains of new minor crops for acclimatisation and subsequent test in Barbados.

(i) ECONOMIC FRUIT TREES.

Citrus.

Eight types of citrus are being propagated and distributed, i.e., lime, orange, grapefruit, shaddock, lemon, mandarin, pomelo and citron. The stocks used were rough lemon and sour orange and propagation done by budding. The scion material consisted of (1) budwood of established commercial varieties imported from Trinidad and (2) budwood from local vigorous seedling trees bearing fruit of good quality. The latter, as might be expected, appear to be better adapted to Barbados conditions and, since they bear fruit of very good quality, it is probable that in the near future they alone will be propagated.

During the year, 584 budded citrus plants were distributed, the chief kinds being lime, grapefruit and orange.

Two further stock nurseries were established to provide for approximately 1,500 budded citrus plants for distribution during the 1939—40 season.

For purposes of obtaining scion material, one plant at least of each citrus variety used was planted in an orchard at Codrington Botanic Station. At present, thirty-five citrus varieties are established in the orchards at the Station.

Avocado Pear.

In addition to the obvious desiderata of good yield and good fruit quality, the work with pears aims at propagating varieties yielding good keeping and carrying fruits and also varieties which bear during the months of January to July, i.e. out of the accepted pear season.

With regard to the former, six varieties of pears were imported from Trinidad. It has been determined in Trinidad that these produce fruits of good keeping and carrying qualities.

Varieties which are stated to bear out of season were imported from Mayaguez, Puerto Rico (six varieties) and Florida (five varieties).

Further selection of varieties has been confined to seedling trees within Barbados. Here it has been possible to select for (1) good bearing (2) good fruit quality and (3) bearing out of season. For these local varieties, no information is available as to their keeping and carrying quality.

Twenty-nine varieties, i.e. both introduced and local have been established in orchards at Codrington Botanic Station.

Propagation to date has been done by budding and grafting on young hardy pear seedling stocks and using scion material from local seedlings only.

During the season under review, 75 trees were distributed. These consisted chiefly of trees propagated from 14 local varieties, approximately half being derived from trees bearing out of season. It is anticipated that 200 to 300 further trees of this season's propagation will soon be ready for distribution.

It is intended to develop this pear work appreciably, since pears thrive well and produce good quality fruit in Barbados.

Mango.

Prior to the recent commencement of distribution by the Department of grafted mangoes, the vast majority of trees in the island was seedlings. These produced fruit of inferior quality. As a result, appreciable importation of good quality fruit takes place.

Barbados is well suited to growing mangoes and the Department has started to improve the local product by (1) propagating and distributing grafted trees of good varieties and (2) top-working valueless seedlings with good varieties.

With a view to having material for future approach grafting work up to date, 18 grafted trees have been planted in two orchards. These include well known varieties such as Julie, Ceylon, Peter, Bombay, Pere Louis and local seedlings of good fruit quality such as Dr. Rowland, Dora Barbadensis.

During the season, through the courtesy of private growers, it was possible to propagate from grafted trees of reputable varieties. Five hundred and forty grafted plants were distributed, the variety Julie being chiefly used. In addition, 558 are in the process of being grafted and 100 are being hardened off prior to distribution.

Several seedlings belonging to private individuals were top-worked. The object of this was to decide on the most suitable method to adopt in future top-working on a large scale. "T" and "wedge" grafting and "patch" budding were tried. So far it appears the "T" grafting method is most suitable. Further work on this aspect of mango propagation will be done.

Breadfruit.

A rapid method of propagating breadfruit was adopted. This consists in cutting lengths of roots into one foot pieces, protecting the ends by dipping in creosote and just covering these pieces by placing them lengthwise in sharp sand in a form of solar propagator. The sand is kept moist by daily watering and the young suckers when about 3"—6" high are severed with a heel of root tissue from the parent root and allowed to root in the sand in the propagator. On rooting, they are potted in ordinary top-soil and hardened, at first in a box with a cheese-cloth cover and then out in the open. By this method an original 25 feet length of root has given 150 plants and many more are expected.

As with avocado pears, so with breadfruit it has been noted that individual trees bear consistently out of the normal season. Advantage is being taken to propagate from roots of such trees.

During the season under review 42 young breadfruit trees were distributed.

Miscellaneous.

In addition to the above fruit trees, 60 guavas of the varieties "french" and "common" and 37 true fig trees were distributed. The latter are of the self-fertilizing type and bear heavy crops of large dark-blue figs.

Coconuts of the "dwarf" variety were imported from St. Lucia for distribution and sixteen of these were retained for growing in the orchards in the Botanic Station. During the season under review, 3,156 nuts were imported from St. Lucia and distributed to growers.

(ii) GROUND PROVISIONS, PULSES, GRAINS.

(a) GROUND PROVISIONS

Cassava.

Five sweet and five bitter varieties of cassava were imported from the Department of Agriculture, British Guiana. These were multiplied for test against the local varieties during season 1939—40.

Sweet Potato.

Over 36,000 slips of eleven of the sweet potato seedlings recently produced by the Department were distributed during the season.

Four varieties from New South Wales were imported for test against the local types.

Eddoes, Tannias.

Six varieties were imported from the Canal Zone via the United States and Kew. A further seven varieties were imported direct from the Hawaiian Agricultural Experiment Station, and more recently, one variety from the St. Kitts Agricultural Station.

The Canal Zone and Hawaiian importations were grown in observation plots. On harvesting these, notes were made on appearance of corms. Three only were retained for test against the local eddoes, i.e., one from Hawaii and two from the Canal Zone. The others were obviously inferior to the local types under Barbados conditions.

During the season a collection of varieties were received from Fiji. These, however, had become mixed in transit and a second importation is to be made.

(b) PULSES.

Pigeon Pea. (Cajanus Cajan (Linn.) Mill sp).

The local pigeon pea is evidently very mixed in type and it would appear that it would be a useful medium for the selection of economic types. In general, however, it bears during December—February and then, to a smaller extent, around Easter.

It was desired to find out if types could be obtained which yielded at seasons other than those noted above for Barbados types. Importations were made from Trinidad (two strains), Central Provinces, India (two strains), Bihar, India (six strains) and St. Kitts (two strains).

These were grown in comparative observation plots with Barbados types. At present, indications are that the Trinidad types yield at the same seasons as the Barbados types although somewhat later and their yield is inferior to

the latter. No definite information is yet to hand with regard to the Indian and St. Kitts strains.

All are being sown monthly to note their yields and more especially their time of yielding. Pigeon peas are well adapted to the soil and climate of Barbados and it is very desirable to have strains growing which together provide yields of this very valuable pulse crop throughout the year.

Bonavist. (Dolichos lablab, Linn).

This is a very valuable shorter-season herbaceous pulse crop in Barbados

A trial was laid out to test nine strains imported from Kenya against four local types. Unfortunately mosaic disease appeared in the imported strains and the trial was abandoned. The Kenya importations have since been sown in isolated plots.

Tepary Bean (Phaseolus acutifolius, A. Gray var latifolius, Freem.)

Dew Gram (P. aconitifolius, Jacq.)

Green Gram (P. aureus, Roxb.)

The Tepary Beans were imported from Barberton, Transvaal, and the Grams from Coimbatore, India. Field tests were made. The Grams proved to be very slow in yielding and to give a type of bean too small for the local market. The Tepary Bean, however, yielded exceptionally quickly (eight weeks) and gave an estimated bean yield of 5,000 lb. per acre. The beans were attractive in appearance and tasted well when boiled.

The so-called Rounceval and Black-eye peas grown in Barbados are cowpeas. Good yields from those approximate to 3,000 lb. per acre after a 14/16 weeks growing season.

It would appear therefore that the Tepary Bean gives great promise as a very quick and high yielding pulse crop. It is being multiplied and distributed to growers.

(c) GRAINS.

Guinea Corn.

Seven strains were imported from Egypt and seven from Nigeria to test against the two recognised Barbados strains, i.e., "early" and "crop" corn. Duplicate and triplicate single row comparative observation plots were sown and, at the same time, each strain was sown in an isolated plot. In every case, birds ate the grains as they ripened on the heads. It was thus impossible to get dependable yield data. It was, however, possible to make accurate notes on habit, rate of growth and maturity, size of heads and grain and to get some idea of comparative yields.

On these features six of the Egyptian strains and four from Nigeria were retained for further test. These gave indications of giving good yields of good sized grains in a much shorter growing-period than the Barbados strains.

All ten importations have been re-sown with the two local types as standards.

Indian Corn, Maize.

Four varieties were imported from British Honduras and have been sown in observation plots.

Dry Paddy.

A seed sample of dry paddy was received from Coimbatore, India. This type is stated to give good yields under rainfed conditions.

The seeds were sown in the field and grew well. The plants at first appeared healthy but eventually developed chlorosis: probably a lime chlorosis. The majority of the plants succumbed. A few, however, remained green and produced good heads of grain. These have been selected and re-sown with the object of selecting for lime tolerance.

Italian Millet.

Six strains of Italian millet were imported from Coimbatore, India. These were sown together in (1) randomised blocks and separately in (2) isolation plots.

From these initial tests, three were selected. These were re-sown in isolation plots only.

The grains were very attractive to birds and marked losses were caused thereby. Added to this is the necessity for threshing the heads. No machinery exists for this purpose and it has to be done by hand.

Although the calculated grain acre yields were reasonably good, it is doubtful, for the reasons stated above, if this millet will be of any use in Barbados.

Seed will be distributed to growers for small-scale tests.

(iii) VEGETABLES.

Eschalot.

Bulbs of an eschalot variety grown in St. Vincent were imported and tested for yield and quality. These proved highly satisfactory and have been extensively distributed among growers. Excellent reports on their performances have been received.

An importation of onion seed from Montserrat was found on sowing to include many plants of eschalot. These plants produced good leaves and especially excellent bulbs. The latter were harvested separate from the onions and are now being tested against the St. Vincent type.

Cantaloupe.

Previous growing of cantaloupes in Barbados has been made almost impossible through frequent and heavy attacks of mildew.

Through the courtesy of Messrs Peter Henderson & Co., seed suppliers of New York, a sample of seed of the recently produced Cantaloupe No. 45 mildew resistant, was obtained.

This was grown originally in strip plots with four well known varieties from the United States of America. The latter, in spite of repeated dustings with flowers of sulphur, quickly succumbed to mildew. The No. 45 variety proved to be highly resistant and bore an exceedingly good crop of fruit. The latter proved to have an excellent flavour.

Further large scale tests confirmed these findings.

The seed of this variety is now on the market and is being imported by the Department for distribution to growers.

Onion.

Seed samples of (1) "Red Bombay" and (2) "Crystal White Wax" onion were imported from Montserrat. These were put into garden tests. It transpired that the seeds were mixed and contained, in addition to the varieties mentioned above, seeds of eschalot.

Further "Crystal White Wax" seed has been obtained from elsewhere, the "Red Bombay" bulbs were segregated and have been replanted to obtain seed, while eschalots have been put into a trial against the St. Vincent type.

Okra.

A seed sample of a strain of okra was obtained from the office of the Vegetable Research Scheme, Kirkee, India.

This was grown in tests against the Barbados "Six Weeks" and Lady's Fingers" okras.

These tests showed the imported type to start yielding in about seven weeks from sowing and to yield over a period of ten weeks. Actually it had given its crop almost before the Barbados types had started to yield. The actual yields of okras were greater than the Barbados types. The okras were found to be less slimy than the Barbados types. They were tender and well flavoured.

This okra is now being multiplied for seed and the seed distributed to growers.

Stringless Beans.

The high-yielding, good quality variety, "Bountiful" is rather susceptible to mosaic, mildew and rust.

U.S. No. 5 Refugee Bean, which is said to be resistant to mosaic was tested against "Bountiful". No mosaic disease, however, appeared in the plots.

The yields of "Bountiful" were almost twice that of U.S. No. 5 and moreover about fifty per cent. of this yield occurred before the U.S. No. 5 plots had started to yield. The pods of U.S. No. 5 were of excellent quality but rapidly deteriorated after picking. U.S. No. 5 has been discarded.

Further tests were made with (1) Giant Stringless Bean and (2) Mosaic Resistant Refugee Stringless Bean. The seeds were obtained from Peter Henderson & Co. The former is said to be resistant to bean blight. These were tested against "Bountiful."

The mosaic resistant Refugee Bean gave a poorer and later yield than "Bountiful". At the same time the pod quality was poor.

The Giant Stringless Bean on the other hand gave as high a yield as "Bountiful" and over the same period. Its pods, moreover, were of excellent quality and kept as well as "Bountiful". It is undergoing further tests against "Bountiful".

Tests with Indian Vegetable Seeds.

Up to the present, except for notable examples like cauliflower and onion, most vegetable varieties proved best suited to Barbados have been grown from seed obtained from reputable firms in the United States of America.

Considerable development in the acclimatisation and selection of temperate country vegetable strains for the plains of India has been effected in recent years, notably by two firms, i.e., Messrs. Sutton & Sons, Calcutta, and Messrs. P. P. Pocha & Sons, Poona.

During the season, seeds of an appreciable range of vegetable types were imported from these firms. These importations are summarised here.

Type.	Messrs. Sutton & Sons. No. of varieties.	Messrs. P. P. Pocha & Sons. No. of varieties.
Garden Pea	3	4
Bonavist Bean	....	1
Lima, Climbing	1	....
Eggplant	1	....
Radish	4	2
Turnip	1	1
Tomato	1	....
Onion	2	2
Cabbage	3	3
Cucumber	1	2
Watermelon	1	....
Cantaloupe	3	1
Squash	1	....
Spinach	1	....
Kohl-rabi		2
Okra		1
Rhubarb		1
Totals	23	20

In the majority of cases, tests have already been started to compare the above varieties of each type with the accepted standard variety or varieties. The results of these tests are awaited with interest.

(iv) NUTS, OIL SEEDS.

Soya Bean.

Seeds of varieties were imported from two sources, i.e., (1) the Imperial College of Tropical Agriculture, Trinidad, and (2) the United States of America.

During the season the following varieties were tested one or more times: I.C.T.A. (a strain originating in Venezuela and further selected at the College) and from the U.S.A., Biloxi, Yellow Mammoth, O-Too-Tan, Nanda, Palmetto, F.C.22,579 Tokyo, Mamloxi, F.C.22,577 Haberlandt, Charlee, F.C.22,495 Hollybrook, F.C.22,578 Mammoth Yellow, White Biloxi, F.C.22,576 Easycook, Mamredo, Delsta. Seeds of the last twelve were recommended and supplied by the Division of Plant Exploration and Introduction of the United States Department of Agriculture.

Of all the varieties tested, it was evident that the I.C.T.A. strain was the only one which showed any suitability to Barbados conditions. The varieties from the United States of America germinated readily, were short season types, produced comparatively little vegetation and gave low yields of beans. It was clear that they were quite unsuited to tropical conditions and it was doubtful if acclimatization and selection would improve their yield to an economic level.

The strain from the Imperial College of Tropical Agriculture was slower in maturing, but gave larger plants and heavier yields of very attractive looking beans. This variety was tested in several trials. Inoculation of its seeds with the appropriate symbiotic bacterium prior to sowing did not appear to have any beneficial effect. Establishment of plants was also difficult, the seedlings being very attractive to cutworm. One trial, however, was well established, grew uniformly and vigorously and its results were taken as a fair indication of the possible performance of a strain of soya bean comparatively well suited to the tropics and grown under good field conditions.

From sowing to completion of picking lasted eighteen weeks. The yield of beans (one half-acre was grown) was computed at 760 pounds per acre or approximately one-third ton.

This yield is qnite uneconomic at the present price of soya beans.

In conclusion it seems clear that, for Barbados, unless a strain of beans can be evolved or introduced which is hardier and gives appreciably higher bean yields, the growing of soya beans would not be worth while.

Ground Nuts.

These are grown in the drier districts of Barbados during the rainy season. The local varieties used are of the running type which give only fair yields after a long growing season and are difficult to dig.

The nuts are used for human consumption only and appreciable importations are made to supplement the local produce.

An attempt is being made by introduction of new varieties to increase yields, to shorten the crop period and to facilitate digging. The following introductions were made during the season and are being tested against local types:—

(1) From Department of Agriculture, Southern Rhodesia:
Jumbo, Virginia Bunch, Valencia, Masumbika.

(2) from Department of Agriculture, Nigeria:
Castle Cary, Samaru 38, Kano 38, Ceylon 19, Local Mixture, Philippine White.

(3) From U.S. Bureau of Plant Industry:
Valencia, Tennessee Red, Virginia Bunch, North Carolina Runner.

Castor Oil.

Considerable areas of waste land occur in Barbados especially in coastal areas and in the so-called Scotland district. These are denuded of vegetation or carry a scrub vegetation and the areas in the Scotland district, on account of their denuded nature, experience appreciable soil erosion.

Local varieties of castor oil thrive well in these areas, but they are naturally poor and late yielders.

Seeds of castor oil varieties were imported from India (via Trinidad) and direct from India.

In all, seven varieties are being tested against the local types in conditions characteristic of the waste areas.

Sesame.

Seed samples of varieties of this oil crop were obtained from Nigeria, Tanganyika and Trinidad.

These were tested in observation plots. Indications are that this crop is not suited to Barbados agriculture.

(v) MISCELLANEOUS.

GRASSES.

(a) *Fodder.*

An appreciable fraction of the agricultural land in Barbados is laid down in so-called sour-grass (*Andropogon pertusus*) pastures. These occur wherever the soil becomes so shallow as to render uneconomic the growing of sugar cane. These grass areas are in effect permanent meadows. The sour grass is a tufted perennial which thrives well under the conditions and gives two to three cuttings per year. The grass may be used as animal fodder or more recently, it has been advocated and used as a surface mulch in young cane.

The recent success noted elsewhere of several species and strains of *Cenchrus* in the dry tropics suggested its importation and test in Barbados; the chief aim being to note if any could better sour grass. The following importations were made:—

(1) from Kenya:
  Cenchrus ciliaris.
    (i) erect strain.
    (ii) low strain.
(2) from Tanganyika:
  C. ciliaris.
    (i) type C.
    (ii) ,, D.
(3) from Coimbatore, India:
  C. pennisetiformis.
(4) from Punjab, India:
  C. setigerus.
    (i) purple non-hairy.
    (ii) white hairy.
(5) from Pretoria, South Africa:
  C. ciliaris.
    (i) from Springbok Vlakte.
    (ii) ,, Maricostroom.

All importations have been established in observation plots at the Botanic Station under conditions resembling those of sour grass pastures.

(b) *Lawn.*

Java grass plants (*Polytrias racemosa*) were imported from Trinidad and tested under typical devil's grass (*Cynodon dactylon*) and savannah grass (*Axonopus compressus*) conditions. Under the drier exposed conditions of typical devil's grass lawns and turfs, the Java grass is showing better growth to form an attractive, close, springy turf.

Cocoa Quarantine.

In connection with the work of the Cocoa Research Scheme, the Agronomist of the Department of Agriculture, Trinidad, paid visits to cocoa-growing areas in Ecuador and the upper reaches of the Amazon. The primary object of these visits was to discover potential commercial cocoa trees with immunity or high resistance to witch broom disease.

The seeds collected on these visits were sent to Barbados, where they were germinated and the seedlings grown for purposes of intercepting any diseases or pests prior to forwarding to Trinidad.

This quarantine in Barbados necessitated the erection of two shelters in the Experiment Station to give the necessary shade and shelter from wind. At the same time, it was found necessary for effective seedling growth, to compost a soil; the Barbados soil being unsuited to the healthy growth of the seedlings.

Consignments of budwood from this quarantined material have been sent to Trinidad from time to time during the season.

(b) REPORT ON CHEMICAL SECTION

BY

C. A. COPPIN,
Government Analyst.

ANALYTICAL WORK.

1. FOOD AND DRUGS LABORATORY.

The total number of samples examined during the year for the various Government Departments and for private individuals was 1,469.

The number and distribution of samples dealt with annually for the past four years is set out in Table I.

TABLE I.

	1935	1936	1937	1938
1. Police Department	494	516	449	634
2. Customs Department	131	88	74	111
3. Public Works „	13	8	6	13
4. Agricultural „	45	55	31	35
5. Sanitary & Parochial Departments	10	10	45	119
6. Agricultural Society	349	349	367	275
7. Other Govt. Depts.	3	13	36	76
8. Private Individuals	229	243	163	206
TOTALS	1,274	1,282	1,171	1,469

Particulars of the various samples analysed in the Food and Drugs Laboratory for 1938 are:—

1. Police Department.

Viscera and examinations for poisons	52
Coins and Counterfeiting exhibits	140
Butters, margarines and cooking oils	74
Milks	134
Tea, coffee, cocoa, tapioca, flour	137
Rums	59
Miscellaneous	38
Total	634

NOTES:

Viscera and Examinations for Poisons:

Atropine and Morphine: Three and one quarter grains of alkaloids were separated from portions of viscera. Atropine predominated, and in a quantity sufficient to have caused death. Morphine was also present as well as traces of Strychnine. Other substances present indicated that deceased either took or had administered some vegetable extract—probably as a "bush tea" a short time previous to death.

Rubber Solution: A quantity of rubber dissolved in benzene—a typical rubber cement—was found spread on the sliced surface of bread.

Arsenic: Nineteen and one quarter grains of Arsenic as White Arsenic was found in the stomach contents of samples of viscera, etc.

Arsenic was also found in the samples of viscera taken from a body that had been exhumed after burial for eighteen days. All the organs were in a relatively good state of preservation and the distribution of the arsenic was as follows:—

Liver	. 6 *grain*
Spleen and Kidney	.06 ,,
Stomach and Contents	.12 ,,
Intestines	.15 ,,

Traces of arsenic were also fouud in the hair and nails.

Atropine, Aconitine: One-twelfth grain of these alkaloids, together with a quantity of Tannin was separated from portions of viscera. This appeared to be another "bush tea" case.

Washing Soda: Three quarters of an ounce of washing soda was found in a quantity of cooked food submitted.

Powdered Glass: Thirty-two grains of coarsely powdered glass was separated from a quantity of cooked food.

Coins and Counterfeiting Exhibits.

Fifty seven coins were submitted for examination. Of these, fifty-one were found to be counterfeit. The other samples were submitted in connection with these coins—they comprise chiefly: metal and alloys of a composition similar to that of the coins, moulds, charcoal, acids, Plaster of Paris, etc.

Butters, Margarines, Cooking Oils.

All samples were fonud to be genuine.

Tea, Coffee, Cocoa, Flour, etc.

Two samples of cocoa and two of cocoa essence were found to be deficient in cocoa fat.

Milks.

Twenty-three samples of milk were found to be adulterated—19 by means of added water and four by abstraction of milk fat. The percentage of samples adulterated for the past four years is set out in Table II.

TABLE II.

	1935	1936	1937	1938
Percentage Adulterated	32	30	34	17

Rums :

Of the fifty-nine samples examined —three were below the statutory strength of 25 degrees Under Proof.

Miscellaneous.

These inclnde chiefly :—

Samples of stomach remedies sold hy persons other than licensed druggists

Samples of stout and of a coloured sngary liquid resembling rum.

Clothing badly corroded by means of concentrated sulphuric acid.

Two samples of opinm in a case of opium smuggling.

Powder consisting of Tartar Emetic sold by mistake for Tartaric acid.

Exhibits of clothing, etc., saturated with kerosene oil in a case of attempted incendiarism.

A liquid alleged to be used as an abortifacient was found to contain chiefly Iron Ammonium Citrate.

2. Customs Department.

Petroleum	32
Condensed Milk	17
Butters and Margarines	18
Textiles	29
Miscellaneous	15
	111

Petroleum.

Petroleum samples comprise kerosene for flash point determination and petrol for Specific Gravity determination. Samples of crude oil were also examined for petrol and kerosene content.

Condensed Milk.

All samples of condensed milk submitted contained more than nine per cent. fat.

Textiles.

These samples were mixed goods for determination of silk, wool and cotton contents in connection with their importation under the quota law.

One sample of silk, four samples of wool and eleven samples linen were found to be 100 per cent.

Seven samples of silk, guaranteed to contain not less than 60 per cent. silk, were found to contain proportions varying from 30 to 53 per cent. silk.

Five samples wool guaranteed 50 per cent. were found to contain a proportion just slightly below this figure.

Miscellaneous.

These comprise chiefly samples of Wood Spirit and Methanol for report on suitability for denaturing rum.

Samples of apple juice, ghee, tomato paste and high temperature cement were submitted for classification.

3. Public Works Department.

Analyses were carried out on the water as supplied to the general public during the year. A high standard of organic purity was maintained. During November, owing to the very heavy rains, an infiltration of inorganic matter, chiefly clay, was observed at one of the sources; there was no organic contamination.

4. Department of Agriculture.

Samples examined were chiefly sour grass in connection with the manuria trials.

Two samples of soya bean meal were also examined.

Samples of molasses and of the rum made from it were examined in connection with the Vieux Fort plant, St. Lucia.

5. Sanitary And Parochial Departments.

A sample of rice submitted by Sanitary authorities was found to be unfit for human food.

The free chlorine content of the E. C. Disinfectant supplied by the Commissioners of Health was periodically determined.

The Commissioners of Health of St. Michael also submitted seventy samples of milk of which seventeen samples were adulterated. Thirty-two samples of water taken monthly from relatively shallow wells were submitted by the Commissioners of Health, St. Michael. The results showed:—

14 samples fit for drinking and domestic use.
7 samples suspicious for drinking and domestic use.
11 samples unfit for drinking and domestic use.

6. Agricultural Society.

One hundred and twenty-four samples of Feeding Stuffs and twenty-six samples of Fertilizers were submitted by the official samplers under the Fertilizers and Feeding Stuffs Act. All samples conformed to their guaranteed analyses.

One hundred and fifty samples of sugar and fancy molasses were analysed in connection with the prize awards of the Annual Industrial Exhibition. A report on these analyses is submitted to the Agricultural Society.

7. Other Government Departments.

Thirty-six samples of the E. C. Disinfectant supplied to the Hospital were examined.

A sample of condensed milk was also submitted by this Department.

Four samples of condensed milk were examined for the General Board of Health in connection with the scheme for furnishing milk to school children.

A sample of water was examined for the Chief Medical Officer, St. Vincent.

A number of analyses were made on fancy molasses for shipment to U.S.A.

8. Private Individuals.

The following analyses were carried out during the year:—

Sugar and molasses	102
Cane juice	33
Hydrometers, etc., for calibration	10
Fertilizers	28
Milks	5
Waters	5
Miscellaneous	23
	206

The fees receivable by Government for these analyses amounted to £120. 5. 3.

2. SUGAR LABORATORY.

The sugar and molasses manufactured at the various factories and plantations are analysed in this Laboratory.

The particulars of the numbers of samples dealt with since this Laboratory was organised in 1929 and run by Government as a commercial undertaking, with Revenue and Expenditure, are given in Table III.

TABLE III.

Financial Year	Number of Samples		Expenditure			Revenue			Excess of Revenue over Expenditure		
	Sugar	Molasses	£	s.	d.	£	s.	d.	£	s.	d.
1929-1930	29,978	8,114	868	0	0	1,904	12	0	1,036	12	0
1930-1931	20,181	9,899	798	0	0	1,504	0	0	706	0	0
1931-1932	18,141	9,712	715	0	0	1,392	13	0	677	13	0
1932-1933	25,916	8,194	761	0	0	1,705	10	0	944	10	0
1933-1934	36,669	10,947	797	0	0	2,380	16	0	1,583	16	0
1934-1935	18,071	10,092	600	0	0	1,408	3	0	808	3	0
1935-1936	43,744	10,998	710	0	0	2,737	2	0	2,027	2	0
1936-1937	41,255	6,267	783	15	8	2,426	2	0	1,642	6	4
1937-1938	45,333	6,533	884	19	10	2,593	6	0	1,708	6	2
1938-1939	46,900	7,561	916	8	8	2,723	1	0	1,806	12	4

3. ANALYSIS OF SEEDLING CANES.

In connection with the genetical work and manurial trials carried out by the Department, representative samples of cane are received for analysis from various centres throughout the Island.

During the year a total of 892 bundles were milled and the expressed juice analysed. When the composition of the whole cane was needed, analyses of the megass were also made.

(c) REPORT ON THE ENTOMOLOGICAL SECTION FOR THE YEAR ENDING 31st MARCH, 1939

— BY —

R. W. E. TUCKER, M.A., B.Ed.

Entomologist.

Entomological work for 1938-1939 was maintained on the lines of the 1937-1938 report. In addition there has been laboratory and general organisation in preparation for the introduction from Campinas, Sao Paulo, Brazil, of a melanic dry area race of *Metagonystylum minense*, a larval parasite of *Diatraea saccharalis*, the small moth borer of sugar cane.

The policy of the entomological section in the control of *Diatraea saccharalis* is, as has been repeatedly stated, a combination of the use of mass reared and timed liberations of the egg parasite *Trichogramma minutum*, and the introduction of any promising parasite of the larval stages of *Diatraea saccharalis*.

The writer left for Brazil in the last week of March, 1939, to obtain biological races of *M. minense*, and if possible, other parasites.

The distribution of laboratory reared *Trichogramma* reached the total of 308 millions during 1938. The climatic conditions during the latter period of distribution and for several weeks subsequent to distribution were marked by heavy, and at times abnormal rainfall, thus constituting a climatic condition not previously encountered in *D. saccharalis* control work in Barbados.

Despite this fact the standardised and certified determinations of field loss and of percentage internodes bored by *D. saccharalis* for 1939 show a decrease in loss and in damage coincident with the increased parasite liberations.

These annual determinations which are made by the Departmental Staff are now available in comparable form over a sufficient number of years to express them in the form of graphs, which are given in the *D. saccharalis* section below.

These graphs show the effect on *D. saccharalis* infestation of the rapid transition of over 40% of the crop grown from the variety Ba.11569 to the variety B.2935; the latter being more susceptible to borer attack and injury than was Ba.11569.

It also shows definitely both in reduction of total field loss and of damage to reapable cane as expressed in percentage internodes bored, that there has been a downward trend in both total loss and in internode infestation, resulting from increased mass *Trichogramma* liberations as shown in the graphs; and that in consequence, the loss caused by *D. saccharalis* is now much less than it was before *Trichogramma* control was instituted.

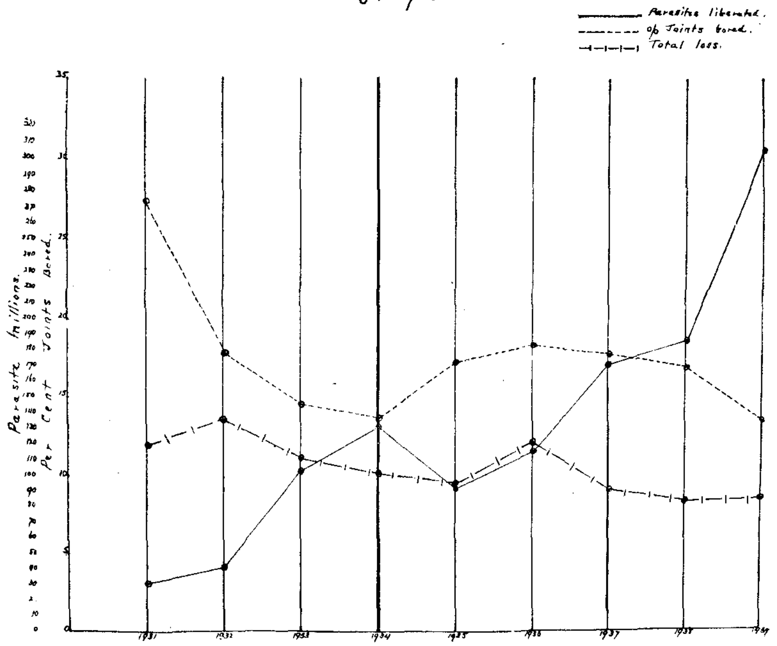
Details of the work of the entomological section are given below:—

Small Moth Borer—Diatraea saccharalis.

During the year under review, the eight new moth units were improved structurally so that their production increased. This, together with a supply of sound grain among other factors, enabled a production of 352,000,000 parasites to be reached, of which 308,000,000 were available for distribution. The relation of this number to previous distributions is shown in Plate I.

The actual distribution of the parasites is entirely in the hands of the planters, and the Department has no control over the efficiency of the distribution. With a few exceptions, however, the parasites are not only obtained

Graph I



Parasite liberated.
% of Joints bored.
Total loss.
Parasite millions.
Per Cent Joints Bored.
1931
1932
1933
1934
1935
1936
1937
1938
1939

regularly by the planters, but are understood to be satisfactorily distributed. There was no difficulty in disposing of the 308 millions available for distribution.

The rainfall during and immediately following the period of distribution was above the average for Barbados, culminating in an average for the island of 8.81 inches in August, 10.58 inches in September, 10.42 inches in October and 28.09 inches in November.

This constitutes conditions different from any encountered in the previous ten years of *Trichogramma* control work.

Abnormal conditions, whether of prolonged lack of rainfall or of prolonged heavy rainfall are, in the case of the relation of the pest *D. saccharalis* to its host plant and parasites, more favourable to the robust, sheltered *D. saccharalis* than to the more fragile, short life cycle, exposed, egg parasite *T. minutum.*

Abnormal climatic conditions may therefore largely offset the effects of increased *T. minutum* liberations.

It is now possible to examine the relation of these annual *T. minutum* liberations in Barbados to an adequate series of certified, comparable, records obtained annually by the Departmental Staff, of the loss caused by *D. saccharalis.*

These records are of total field loss as well as counts of the percentage of reaped cane internodes damaged by borer.

The use of total field loss records in conjunction with bored internode counts is considered indispensable, and such records have always been made and published annually in Barbados.

The figures for each year are shown in graphs on Plate I, which also shows the parasite liberations in millions per year*

* The parasite liberation in any given year influences the infestation in the crop reaped in the next year. Liberation figures are therefore plotted to correspond with the infestation figures influenced.

The conclusion drawn from these graphs is that there is now satisfactory evidence that infestation by, and loss caused by, *D. saccharalis* has been noticeably diminished, and that this diminution is attributable to the annual increased liberations of *T. minutum.*

The graph of annual liberations shows that the extent of *Diatraea* infestation varies with the extent of *Trichogramma* liberations, despite climatic effects, over the nine year period shown, and despite the well defined factor of a rapid change over of at least 40% of the island's crop from the variety Ba.11569 to the variety B.2935 which has been proved to be more susceptible to *D. saccharalis* damage. This change over is indicated by the vertical line traversing the graphs.

It is shown that up to 1934, the three varieties from which records were compiled were Ba.11569, B.726 and B.H.10(12). In 1935, B.2935 appears in equal quantity sampled to Ba.11569, and from 1936 onwards, B.2935 entirely replaces Ba.11569.

The "bored joint percentage" graph in Plate I is the mean of the graphs in Plate II. Each point in each graph of Plate II. is itself the mean of counts made at from five to nine factories.

Twelve factories are visited annually for the compilation of records expressed in Plate II, but some factories use principally two, or even one only, of the three above varieties, whereas at others all three are used. Hence any one variety may be sampled at from five to nine factories out of the twelve.

The graphs are plotted from records made in 1931 onwards because such records are strictly comparable; previous records showing higher infestations and lower parasite liberations than in 1931 are not included.

The annual figures from 1931 onwards, however, show in a satisfactory manner that as *Trichogramma* liberations increase, losses caused by *D. saccharalis* decrease.

Should the larval parasite introduction mentioned earlier in this report prove successful and effective in permanent establishment Barbados will have progressed towards an economic control over *D. saccharalis.*

The economic aspect of *Trichogramma* breeding in Barbados is as follows.

The working expenses for the year 1938-39, during which 308 million parasites were distributed to the planters was £1,450. This figure includes all material, labour and salaries (total and proportional); it does not include capital expenditure on buildings.

The above amount works out at 17.4 cents (8¾ pence) per acre of cane per year.

If all capital expenditure on buildings and equipment is included, and written off completely over the operating period of 10 years, it adds another 3.6 cents, making a total of 21 cents or 10½ pence per acre of cane per year.

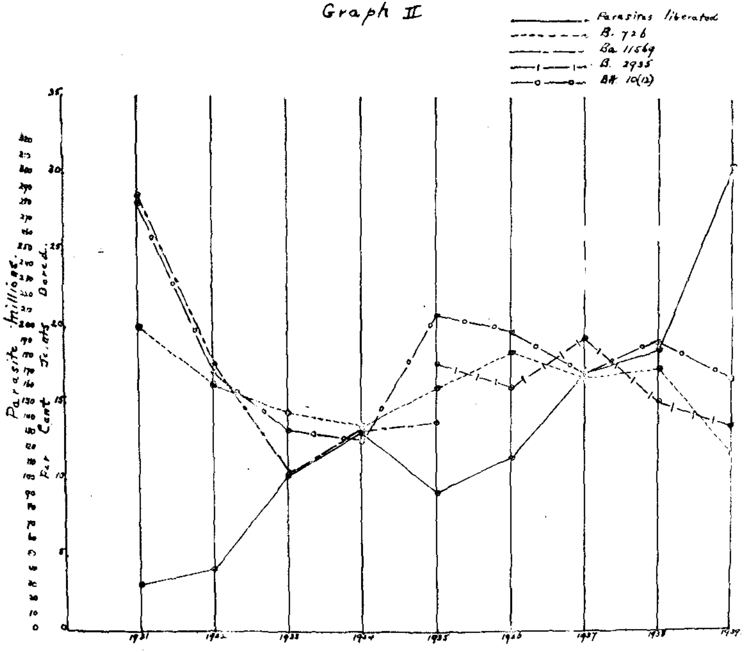
Having thus written off capital expenditure future production expenses for *Trichogramma* should not exceed 17½ cents per acre per annum. Even if this is considered as a permanent expenditure the amount is negligible as expenditure for control over such a serious pest as *D. saccharalis* in sugar cane.

Cane Varieties and D. saccharalis.

Work on the relation between borer damage and cane varieties was continued on the organised plan reported last year. Investigations are not sufficiently advanced yet for conclusions to be drawn other than that moth borer damage is definitely connected with cane variety.

This fact also emerges from the records of field loss of which sufficient are now available for analysis.

Graph II



Parasites liberated
B. 726
Ba 11569
B. 2935
B# 10(12)
Parasite Millions
Per Cent Plants Bored.
1931
1932
1933
1934
1935
1936
1937
1938
1939

These records show that for the years 1935 and 1936 when Ba.11569 and B.2935 were about equal in acreage and samples taken the field loss for Ba.11569 (30 fields sampled) was 11.18%; for B.2935 (34 fields sampled) it was 12.80%; for B.H.10(12) (19 fields sampled) it was 12.01%; and for B.726 (49 fields sampled) it was as low as 9.02%.

As has been previously stated B.2935 which replaced Ba.11569 from 1936 onwards is more susceptible as shown by both field and factory records than the variety which it replaced.

This is a comparison between established commercial varieties only. It is hoped that it will be found possible to discover resistant varieties which, if they do not reach the stage of competing successfully with established varieties, may be of use for breeding work and for determining those characters which make a cane resistant to the attacks of *D. saccharalis.*

Root Borer of Sugar Cane (Diaprepes abbreviatus) and Brown Hardback (Lachnosterna smithi).

During the year under review, the organisation of plantations into groups for the purpose of collecting beetles was revived and stimulated by a Government grant of £250 towards the cost incurred by planters in paying for beetles collected. Planters appear to have co-operated quite well in this voluntary scheme, but, from total returns sent in, only 1,400,000 root borer beetles were collected, though 6,600,000 brown hardback beetles were collected during the same period.

It is considered that this shows a diminution in the number of root borer beetles (*D. abbreviatus*) available for collection.

Collection of adult beetles has, however, repeatedly been stated to be only a part of the control measures recommended, the other measures being destruction of grubs in the soil by ploughing and digging out stumps and cane boles, and rotation of crops, especially in fields showing signs of either pest.

The maintenance of artificial ponds for the breeding of the giant toad *Bufo marinus* is also recommended; such ponds can be rendered mosquito proof by use of the small fishes called "millions".

A paper on the control of *D. abbreviatus* and of *L. smithi* in Barbados, including a discussion on hand collecting under local conditions, is being published in the Journal of the Department of Science and Agriculture, Barbados, Vol. 8, No. 1.

The imported predator *Pyrophorus luminosus* has been seen in small numbers in the region of original main liberations.

This predator of brown hardback grubs was introduced 4½ years ago, but the numbers now in evidence do not unfortunately indicate any increase, or likelihood of widespread or permanent establishment.

Scarabee—Euscepes postfasciatus.

No further work has been carried out on this pest, and the position is as recorded in last year's report.

Cotton Pests.

Very little cotton was planted in 1938, but the amount planted provided interesting comparisons.

Estate cotton, planted in large contiguous fields was completely defoliated over the Christmas week end, up to which time protection had been afforded by dusting with Paris green and lime. These defoliated fields barely yielded sufficient cotton to pay expenses. In contrast, small peasant plots were not attacked and defoliated by *Aletia argillacea*, and many of the plots gave excellent yields of over 1,000 lb. of seed cotton per acre.

Very little pink bollworm was recorded this year.

A paper on cotton growing and pest control in Barbados is being published in the Agricultural Journal of the Department of Science and Agriculture, Barbados, Vol. 8, No. 1. The close season, time of planting cotton and measures of field sanitation consistently recommended for Barbados still hold good, and can control pink bollworm. For defoliation control, wet spraying with lead arsenate is recommended in place of the generally practised dusting with Paris green and lime.

Termites.

The species of termites prevalent in Barbados have been identified by Dr. A. M. Adamson, of the Imperial College of Tropical Agriculture, and sufficient information has now been accumulated from buildings and canefields for publication at a later date.

It can be stated in this report that a species, at present unidentified,* of the dangerous genus *Coptotermes* is present in buildings in Bridgetown, particularly in the Baggage Warehouse.

The well known *Cryptotermis brevis* is present in houses and furniture, and the widely spread *Nasutitermes costalis* is the cause of considerable damage to growing canes in fields, and to ornamental trees, etc.

In addition there is probably a new species of *Neotermes,* and a new species of *Kalotermes,* and a species resembling but apparently differing slightly from *Heterotermes tenuis.*

Termites are therefore of more than minor importance in Barbados, and the work of examining buildings and canefields to determine the extent of damage, to give advice on means of controlling and reducing termite damage, and to obtain adequate specimens for identification and eventual mapping of species, keeps a Wood Ant Inspector appointed for this purpose fully occupied.

Fuller accounts of termites in Barbados will be published in due course.

Rat Control.

The change from barium baits to Thallium baits in linseed oil containers, which were prepared and distributed in large numbers by the Planters' Association, proved successful in 1938.

Preparations have already been started for distributing still larger quantities of this bait in 1939.

The payment by Government for heads of rats and mongoose was stopped last year, and in place of it, a subsidy of £250 was given towards making the thallium baits cheaper and therefore more readily used by planters and merchants.

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* Since this was written, the species has been identified by A. E. Emerson as *Coptotermes havilandi* (Holmgr) a species native to the Malay regions.

(d) REPORT OF THE PLANT DISEASES INSPECTOR

BY

D. R. D. WILES

(1) MOSAIC DISEASE OF SUGAR CANE.

The systematic inspection of the cane crop for the presence of the mosaic disease of sugar cane was carried out for the period under review until the canes became too high for proper inspection to be made. No additional areas were added to the list of Proclaimed Infected Areas during the year.

The Corn Close Season was again proclaimed for the usual period of three and a half months (16th December, 1938, to 31st March, 1939). No difficulty was experienced by the Inspectors in enforcing this close season.

Owners and occupiers in the Proclaimed Infected Areas were supplied with *cane plants, free from mosaic disease, during the planting season,* under the supervision of an Inspector from the following centres:—

Parish.	*Centre.*	*Variety.*
St. Michael	.... Waterford Plantation.	B.2935.
St. James	.... Bennetts Plantation.	B.2935.
St. George	.... Groves Plantation.	B.H.10(12) & B.726.
St. John	.... Lemon Arbor Plantation.	B.H.10(12).
St. Peter	.... Rockless Plantation.	B.2935.

The districts of Carrington's and Chapman's Villages, St. Thomas, and Sugar Hill Tenantry, St. Joseph were supplied with the varieties B.35187 and B.3254 which had been bred for mosaic disease resistance and had remained quite free during one year. The former variety has also proved itself to be quite a good one surpassing the standard varieties in tonnage per acre.

Prior to the planting season, a more extensive inspection was carried out than heretofore of the canes from which owners and occupiers were desirous of cutting their plants, and it is pleasing to record that only two occupiers in the Proclaimed Infected Areas were prevented from obtaining their plants from their own plots.

Reports on Individual Parishes.

PARISH OF ST. MICHAEL.

The tenantries of Goodland, Ivy and Bank Hall have continued to show a reduction in the number of infected holes found. The majority of the infected holes show signs of secondary infection, due, no doubt, to these districts being large corn growing areas. The areas outside the Proclaimed Infected Area in this parish have remained fairly free and it is hoped that by carefnl selection of planting material this infection will be greatly minimised.

PARISH OF CHRIST CHURCH.

The number of infected holes found in this parish is very much lower than last year and this is, no doubt, due to a more extensive planting of the variety B.2935 for the Ba.11569 by the owners and occupiers in the tenantries of Pegwell and Enterprise. Constant rogueing of the infected holes has kept the infection down in the other areas of the parish and only a few holes were found outside the tenantries mentioned.

PARISH OF ST. JOHN.

The infection found principally in ratoons, in this parish still remains high in the tenantries of Venture, Sherbourne and Carters, but it is hoped that by the distribution of plants of the variety B.35187 during the coming planting season on a more extensive scale the number of diseased holes will be greatly diminished.

PARISH OF ST. JOSEPH.

In the Proclaimed Infected Area of Sugar Hill Tenantry where the varieties B.35187 and B.3254 were distributed two planting seasons ago a more extensive distribution of the former variety was carried out during the last planting season. No diseased holes were found in these varieties during the year and it is hoped that the B.35187 will remain free of infection as it is a variety most suitable to this district. The infected holes found for the period under review were in a field of ratoons near to the Sugar Hill Tenantry.

PARISH OF ST. PETER.

This parish has continued to remain free with the exception of the Farm Road Tenantry and Speightstown Tenantry where only 121 diseased holes were found for the period under review. It is, however, hoped by constant rogueing and the supply of healthy planting material to have these areas comparatively free in the near future.

PARISH OF ST. JAMES.

The heavy infection in this parish was found in the ratoons in the tenantries of Mt. Standfast, Garden, Lower Carlton and Weston as well as on one estate. It is hoped that by constant rogueing as well as by the supply of healthy plants to keep the infection in check until a suitable resistant variety is found.

PARISH OF ST. THOMAS.

The tenantries of Carrington's and Chapman's Villages continue to show a slight improvement and it is expected that, with the distribution of the variety B.35187 during the last planting season, a further improvement will be observed. These areas are ones in which very heavy ratooning is practised and it is impossible to note a great improvement in a short space of time. It is unfortunate that a heavy secondary infection was found in a field of ratoons at one estate and also that a slight recurrence of the disease has taken place in Rock Hall Tenantry which was free for a period of two years and had been removed from the list of Infected Areas.

PARISH OF ST. GEORGE.

The heavy infection which was found in Workman's Tenantry still persists and it is hoped that by constant rogueing and the supply of healthy plants through the Department that this area, which is a ratooning one, will gradually improve. The infection still persists in the tenantries of Newbury, Sweet Bottom and Bel Air but a great improvement has been noted, due, no doubt, to the supply of healthy plants to these areas. The estates in this parish have continued to remain fairly free.

PARISH OF ST. ANDREW.

Spring Vale Plantation which is the only estate on which mosaic diseased stools have been found in this parish continues to show a slight improvement and as the infection is only to be found in the fields on the St. Thomas side of the estate every endeavour has been made to prevent it from spreading.

NOTE ON INSPECTIONS.

No complaints were lodged under the Mosaic Disease (Eradication) Act and all infected holes found were destroyed. It is pleasing to record that the arrival of an Inspector is welcomed by one and all and he is accorded every facility possible by owners and occupiers who now realise the benefit of keeping their crop free of infection.

Table Showing the Number of Infected Holes and the Acreage Inspected During the Past Four Years.

Parish	1935		1936		1937		1938	
	Acreage inspected	Number of infected holes	Acreage inspected	Number of infected holes	Acreage inspected	Number of infected holes	Acreage inspected	Number of infected holes
St. Michael	2,437¾	5.160	2,730	5,242	2.712	4.023	2,366	3,224
Christ Church	3,942¾	451	3,531¾	698	4.209¼	459	3,652	215
St. Peter	1,887	188	2,130	655	2,439½	58	2,011	121
St. James	1,782	634	2,343½	327	1,756¼	2,601	1,486¼	1,237
St. Thomas	1,226½	418	1,539¼	644	1,482¾	692	762¼	720
St. Joseph	532¾	2.421	799¼	3,377	570¾	7.843	303½	79
St. George	2,540½	1.535	2,024¼	572	1,443¼	1,122	1,790¾	5.614
St. John	1,548	696	1,572½	1,267	1,771¾	835	1,451½	1,280
St. Andrew	1.754	2.274	1,011¾	4.916	1,415	1,319	1,002¼	293
Total	17,651¼	13,777	17,682¼	17,698	17.800½	18,952	14,885¼	12,793

(2) INSPECTIONS UNDER THE COTTON DISEASES PREVENTION ACT.

From the 33 acres planted so as to maintain a seed supply a yield of 3,253 lb. of lint was obtained. During the planting season, seed was distributed to plant 77 acres but due to the weather conditions experienced during October and November, 1938, a great deal of this was destroyed and only 56 acres remained to be reaped. No pink bollworm was found in any of the plots in the parishes of St. Philip, Christ Church and St. Lucy but a slight attack was observed in the experimental plots at Warrens in late January, 1939. The cotton leaf worm, *Aletia argillaceae*, was found attacking the estate plots in St. Philip and material damage was done before it was brought under control by dusting. It is recommended that spraying should take the place of dusting as it has been found to be very much more effective.

The Okra Close Season was again proclaimed and lasted from the 1st of January, 1938, to the 31st August, 1938. This period is really a control season as permits are issued to growers to keep their plots under certain conditions during this period. It is pleasing to record that no permits were cancelled for the period under review.

For the period under review, the holds of 13 ships were fumigated with "Zyklon B" and 5,803 bags of imported cotton seed disinfected by means of the Simon's Heater.

Due to the spread of the Mexican Cotton Boll Weevil, the inspection of all articles containing cotton or suspected of containing cotton was carried out in accordance with the provisions of the Cotton Diseases Prevention Act, 1937—24.

(3) MISCELLANEOUS INSPECTIONS OF IMPORTED PLANTING MATERIAL.

742	Packages of Bulbs, Rose Trees, Vegetable and Flower Garden Seeds	Examined and Passed.
3	Packages Carnation Plants	"
48	Packages Orchid Plants	"
20	Orchid Plants	"
7	Packages Anthurium Lily Plants	"
40	Packages Anthurium Lily Plants	"
6	Pear Plants	"
1	Package Mango Plants	"
8	Packages Mango Plants	"
1	Package Lime Trees	"
4	Packages Lime Trees	"
5	Bags Seed Coconuts	"
50	Coconut Plants	"
2	Packages Cactus Plants	"
22	Packages Bulbs	"
3	Packages Palms	"
15	Packages Palms	"
2	Packages Bougainvillea Cuttings	"
1	Package Eschalot	"
3	Packages Hibiscus Cuttings	"
2	Nutmeg Plants	"
2	Packages Poinsettia Cuttings	"
6	Packages Rose Trees	"
2	Bags Pineapple Suckers	"

61 Packages Miscellaneous Plants	....	....	....	Roots Washed.
13 Carnation Plants	....	....	....	....	"
1 Package Lily Plants	....	....	....	....	"
13 Mango Plants	....	....	....	....	"
2 Packages Lime Trees	....	....	....	....	"
1 Package Palms	....	....	....	....	"
3 Ferns	....	....	....	....	"
2 Packages Cotton Seed	....	....	....	....	Fumigated.
4 Bags Cotton Lint Samples	....	....	....	"
27 Coconut Plants	....	....	....	....	Destroyed.

(4) PRODUCE EXPORT CERTIFICATES.

In order to allow the export of yams, sweet potatoes, eddoes etc., and to allow exporters to comply with a Proclamation issued in Trinidad, B.W.I. on the 26th of March 1938 (Trinidad and Tobago No. 13 of 1938), 391 certificates were issued for the period under review. This entailed the inspection of 1,979 packages, the majority of which were tierces, containing vegetables.

(e) REPORT ON PEASANT AGRICULTURE FOR THE PERIOD 1st APRIL, 1938 TO 31st MARCH, 1939.

BY

T. O. PHILLIPS,

Senior Peasants' Agricultural Instructor.

INTRODUCTION.

On July 1, 1938, the Government appointed a Junior Peasants' Agricultural Instructor.

During July he accompanied the writer on visits to several districts in the island. After thus gaining experience, he took over instruction work in St. Lucy, St. Peter and St. James parishes and was stationed at Holetown, St. James.

The annual report submitted by the Junior Peasants' Agricultural Instructor has been incorporated in this general report on peasants' agricultural instruction.

1. EDUCATIONAL.

(a) *Peasants.*

Lectures.

Eleven lectures on general agricultural practices were given to peasants in schoolrooms in different districts.

(b) *Schools.*

(i) *Lectures.*

A course of lectures and demonstrations was organised by the Director of Agriculture on behalf of Elementary School Teachers during the summer vacation. The various specialist members of the staff of the Department were made responsible for lectures on their own particular subjects and the following is a brief summary of the lectures and demonstrations given:

(a) *Lectures.*

Climate and Soils in Barbados.
Soil Improvement.
Plant Morphology and Anatomy.
Plant Physiology.
Vegetative and Sexual Reproduction in Plants.
Plant Diseases.
Plant Pests.
Sugar Cane and Cotton Agriculture.
Livestock in Barbados.
Minor Crops in Barbados.
Propagation and Care of Fruit Trees.
Crop Rotations.
Crop Costings and Marketing.

(b) *Demonstrations.*

Demonstration on Beekeeping.
Visit to a Small Holding.
Visit to Government Stock Farm.
Visit to Codrington Botanic Station.

(ii) *Demonstrations.*

Six demonstrations in planting vegetables were given to pupils of the elementary schools.

Eight demonstrations in methods of spraying citrus and other fruit bearing trees were given to both school children and peasants. It is hoped by these demonstrations to bring home to the growers the necessity for, and the correct methods of, spraying.

(iii) *Inspections.*

All the school vegetable gardens were inspected for the purpose of judging the four best kept, among those entered for the prizes annually offered by the Department of Agriculture.

The successful schools in order of merit were: 1st Black Bess, St. Peter; 2nd St. John Baptist, St. James; 3rd St. Augustine, St. George and 4th Mt. Tabor, St. John.

2. ADVISORY.

(a) PEASANTS

One hundred and ninety-seven districts were visited during the year. These districts are tabulated in the form of an appendix to this report. During these visits, in addition to advice on general agricultural practices, advice was given on: (1) Selection of sites for the planting of vegetables and fruit bearing trees, (2) Spacing distances, (3) Selection of planting material, (4) Time and methods of planting, (5) Mulching, (6) Manures and manuring, (7) Rotations, (8) Insect pest and fungoid diseases and their control, (9) Harvesting stages of vegetables and fruit, and (10) Plant propagation.

(b) SCHOOLS.

The forty-four existing school vegetable gardens were periodically visited and advice was given on the various subjects mentioned in the previous paragraph.

3. DISTRIBUTION OF PLANTING MATERIAL.

(a) PEASANTS.

Planting material of the following was distributed.

(i) *Sweet Potatoes.*

Cuttings of eleven of the new varieties of sweet potatoes produced by the Department.

(ii) *Mosaic Disease Resistant Sugar Cane Varieties.*

The two varieties B.3254 and B.35187 which were mainly distributed in the Sugar Hill area, St. Joseph, have both throughout the 1937–39 season proved resistant to mosaic disease. In addition, the variety B.35187, especially has given excellent cane yields, and seems definitely promising. Further planting material of the two varieties mentioned was distributed in mosaic disease areas during the 1938 planting season.

(iii) *Citrus and Other Fruit Bearing Trees.*

During the year over six hundred peasants placed orders for plants of grape fruit, lime, mandarin, orange, shaddock, lemon, mango, avocado pear, breadfruit, guava, figs (*Ficus carica*) and seed coconuts.

The Department is gradually supplying these orders, although the demand still is greater than the supply.

From the large number of these orders it is evident that peasants are beginning to take a very welcome interest in this phase of agriculture.

(iv) *Other Minor Crops.*

Planting material of the following was also distributed:—onion, cantaloupe, squash, cucumber, sorrel, pigeon peas, okras, eschalot, tomato, cauliflower, cabbage, guatemala grass, fodder canes, pumpkin, Indian and guinea corn, bonavist, bush and lima beans, pineapple, tobacco, cowpeas and tepary beans.

(b) SCHOOLS.

Distribution of the following seeds and/or seedlings was made:—white crystal wax onion, peppers, cauliflower, cantaloupe, eggplant fruit, Barbados squash, pig bonavist, pineapple, chive, eschalot, cucumber, ginger, cabbage and tepary beans.

4. IMPROVEMENT OF LIVE STOCK.

(a) GOATS.

With the main object of improving milk yields, one hundred and seventeen does were served by the British Alpine buck stationed at the home of the Senior Peasants' Agricultural Instructor at Airy Hill, St. Joseph.

(b) POULTRY.

Twelve sittings of eggs of a special cross (Rhode Island Red x Local Bareneck) were distributed to small holders.

(c) TURKEYS.

Nine hens were penned with the three-quarter bred turkey cock stationed at the home of the Senior Peasants' Agricultural Instructor at Airy Hill, St. Joseph.

5. MISCELLANEOUS.

(i) *Surveys.*

Thirty-four surveys were made during the year. Some of these surveys were made in the company of the Director and/or the Assistant Director and Botanist, and two of the members of the Royal Commission.

Most of the other visits were made principally for the purpose of collecting data for the Royal West India Commission which sat in Barbados during January, 1939.

(ii) *Experimental Work.*

Visits were paid to Codrington Experiment Station on Wednesdays and Saturdays of each week for the purpose of assisting with minor crop investigations.

Budwood of the best local varieties of citrus and other fruit bearing trees and root cuttings of good late bearing breadfruit trees were collected for propagation at and distribution from Codrington Experiment Station.

Planting material was also collected of:—pigeon peas, cowpeas, okras, bonavist, yams, eddoes, cassava, guinea and Indian corn, local bush beans, pineapple, coconuts, castor oil and tannia to serve as standards to test against imported varieties.

(iii) *Arrowroot Industry.*

During the first year's working of the arrowroot factory erected at Chalky Mount, St. Andrew, over fifty-six thousand pounds (56,000 lb.) of rhizomes were received at the factory to be manufactured into starch.

Up to the time of writing this report, the second year's grinding operations have begun and it is pleasing to record that already thirty-six thousand seven hundred and seven pounds (36,707 lb.) of rhizomes have been reeeived at the factory.

For the purpose of conducting a manurial trial with this crop nine blocks were selected in four districts during the year, each block was divided into five plots and manured as per attached Appendix "A".

The plots were sprayed once with lead arsenate spray to prevent the attacks from arrowroot worms.

Four blocks have been already harvested and the response in yield of roots has been very gratifying.

In some cases the manured plots gave yields of over 91 per cent. more rhizomes than the non-manured.

The other five plots will be reaped later in the year.

(iv) *Ginger.*

Two samples of locally grown dried yellow ginger have been prepared and shipped to both England and the United States of America.

A report is eagerly awaited, as there are no doubts that if a remunerative market be available this crop could with profit be more extensively grown by the peasants, especially now that the International Sugar Agreement is being enforced.

A Ginger Growers' Association is being formed with headquarters at St. John.

(v) *Cassava.*

The possibilities of developing a cassava starch and meal industry are being investigated.

(vi) *Cotton (Sea Island).*

Peasants who had planted this crop more extensively this year had to face two setbacks, heavy rainfall, and the "*Aletia argillacea*". These two factors caused very poor cotton yields.

(vii) *Rat Control.*

Seven hundred and sixty pounds (760 lb.) of Red Squill rat bait were distributed among peasant holdings. Peasants have expressed their deep appreciation of this and have reported that excellent results have been obtained by its use.

The use of this bait has become so popular with small holders that the demand for it is increasing every year.

(viii) *Distribution of Parasites—(Trichogramma minutum).*

Ninety-one tins of *Trichogramma minutum* were distributed to peasants to assist in controlling the ravages of the sugar cane moth borer (*Diatraea saccharalis*); at the same time opportunity was taken to advise on the methods to be adopted to control and combat the root borer (*Diaprepes abbreviatus*) and the brown hardback (*Lachnosterna smithi*).

(ix) ***Exhibitions.***

(a) *Local Agricultural Exhibition (for Peasants and Elementary Schools).*

This was held at Queen's Park on the 1st of December, 1938. There was a record number of competitors and exhibits.

A record number of small holders also entered for the prize offered by the Department for the best kept Peasant Plot.

In spite of the heavy rains which were experienced during the latter months of the year, both the vegetables and fruits were of a very high standard.

The fifty exhibits of sugar canes were definitely outstanding. These stools of sugar cane were sent from peasant plots which had been manured and cultivated as recommended by the Department.

Among the sugar cane exhibits were four stools of B.35187 (one of the mosaic disease resistant varieties), which attracted the attention of the public.

(b) *General Exhibition (Open to Public).*

This show which was held on December 14 and 15, 1938, was very successful. Peasants again competed in large numbers. The schools also sent in a record number of exhibits.

The exhibit of peasants' goats at this exhibition was also a record one. This was due to the fact that His Excellency the Governor had offered a prize for the best doe kid bred from British Alpine stock and exhibited by a peasant.

(c) *Horticultural Exhibition.*

At this exhibition which was held at Queen's Park on March 18, 1939, peasants entered many fine exhibits of both fruit and vegetables. The standard of both fruit and vegetables is rapidly improving.

6. GENERAL.

The year under review has seen a general improvement in peasant agriculture, and both peasants and elementary school teachers are taking a keener and more intelligent interest in their plots.

A wider variety of crops is being cultivated, better systems of rotations and methods of manuring are being practised, while surface mulching is gradually becoming general.

Vegetable plots are being established, the advice of the Department is being sought, and in most cases carried out.

The number of applications for advisory visits and spraying demonstrations could not all be met, although every attempt was made to do so.

Many peasant holdings are not being made full use of because of the fact that peasants lack the financial help, and also because of their title deeds not being in order.

One is pleased to record that during the year the Government has widened the scope of the Peasants' Loan Bank and has now made it possible for a larger number of peasants to avail themselves of the benefits to be derived from this Bank.

It is also now possible for a wider range of crops to be cultivated.

The prevalence of praedial larceny greatly militates against the extension of the area under food and vegetable crops and an attempt is being made to have the Hawkers' Registration Act (1904–1 and 1921–42) amended so that more effective steps may be taken against this problem.

APPENDIX "A".

MANURIAL TRIAL FOR ARROWROOT.

Plot Treatments.

Plot 1. — No-manure.
,, 2. — N.
,, 3. — K.
,, 4. — N. + K.
,, 5. — N. + P. + K.

Quantities of Manure per Acre.

N. = 2 cwts. sulphate of ammonia per acre.
P. = 2 cwts. superphosphates per acre.
K. = 1 cwt. muriate of potash per acre.

Plan.

Size of plot = 20′ x 25′.

Time of application.

When arrowroot begins to grow—July.

List of Districts Visite

(The figures opposite the

St. Joseph.	St. John	St. Philip	St. George	St. Andrew
Vaughans (2)	Massiah St. (7)	Marley Vale (6)	Green's (7)	Chalky Mt. (
Surinam (5)	Venture (15)	Church Village (2)	St. Luke's	Hillaby (1
Sugar Hill (12)	Edgecliff (5)	Brereton	St. Jude's	Lakes (
Melvin's Hill (2)	Sherbourne (6)	Marchfield. (3)	Prerogative	Belleplaine (1
Clement Rock (7)	Spooners (2)	Cox Hill (2)	Salters (3)	Bayley's La
Bragg's Hill	Stewart's Hill (4)	Foul Bay (2)	Ellerton (2)	Corbin's (
Chimborazo (4)	Cherry Grove (3)	Long Bay (7)	Workman's (8)	White Hill
Horse Hill (4)	Four X Roads (5)	Sea View (6)	Newbury (4)	Cane Garder (
Cleaver's Hill (3)	Gall Hill (2)	Merricks	Sweet Bottom (3)	Baxters
St. Elizabeth's Village (5)	Martin's Bay	Crane	St. George's Glebe	St. Saviour's
Bathsheba	Mt. Tabor (2)	Rices	Market Hill	Mt. All
Layne House	Carter's (3)	Holy Trinity	St. Helen's	Less Beholdi
Airy Hill (4)	Spooners (3)	Harrow	Cole Hill	Rock Hall
St. Bernard's (5)	College Savannah	Moncrieffe		
Coconut Grove (15)	Small Town	Humphrey's Village		
Parris Hill (3)	Rose Gate	Blades Hill		
Industry	Wilson Hill	Work Hall Village		
Retreat		Wheelers (2)		
Burke's Village (2)		East Point (2)		
Malvern				
St. Sylvan's Village				
Senior's				
Total 22	17	19	13	13

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.. ..	994	19	5
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.. ..	2,104	4	7
tur	681	8	0
mor	601	3	9
.. ..	1,043	5	2
met	917	15	4
bee	126	3	8
.. ..	49	19	11
sou	61	10	10
.. ..	39	19	3
tior	39	8	0
.. ..	390	13	9
tha bei	£16,369	15	5

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ation ..	107	15	8
of tication) Act	135	8	1½
hav	2,224	6	0
mor	104	1	0
.. ..	15	15	6
.. ..	82	16	2
Pla	£2,737	18	3

DURING 1938-39.

Qu

ıce and Agriculture Act 1925
of Science and Agriculture

Pla

nt of a Junior Peasants' Agri-
Tin the existing post of **Peasants'**
Agricultural Instructor.

2. 1938-19. *19th May*, 1938.
An Act to make provision for the purchase and development of certain properties in the island of Saint Lucia. Title "The Vieux Fort Land Settlement Act, 1938".
The object of purchase of agricultural land and associated properties of the Vieux Fort Co., Ltd., is to foster the emigration and settlement of Barbados families in Saint Lucia. The Act gives authority for the Executive Committee to subscribe to memorandum and articles of association of a Company to be formed for the development of the property and for the shares to be held in the name of the Executive Committee and two persons nominated by the Governor-in-Executive Committee. The Directors of the Company are five in number, nominated by the Governor-in-Executive Committee.

3. 1938-55. *23rd December*, 1938.
An Act to make provision for the control of the manufacture and export of sugar made in this island. Title "The Sugar Production and Export Control Act, 1938"
This Act was rendered necessary in view of the export sugar quota placed on Barbados as a result of the International Sugar Agreement. This Act authorises the establishment of a Sugar Production and Export Control Board comprising the Director of Agriculture as Chairman and seven other members. The Governor-in-Executive Committee is empowered on the advice of this Board to grant permits for the export of sugar and to demand periodic returns from manufacturers and purchasers of sugar and to control the export of sugar such that it does not in amount exceed the quota. The Governor-in-Executive Committee is further empowered from time to time to fix the maximum quantity of sugar which may be held in stock and also on the advice of the Board to dispose of or make regulations for the disposal of excess sugar.

4. 1939-2. *18th January* 1939.
An Act to provide for the supervision of weighing of canes. Title "Supervision of the Weighing of Sugar Canes Act, 1939".
The object of this Act is to ensure the correct weighing of canes and authorises certain members of the Police or Officer of the Department of Science and Agriculture to visit places where canes are being weighed and check the weighings.

APPENDIX I.

METEOROLOGICAL OBSERVATIONS RECORDED AT THE METEOROLOGICAL STATION, CODRINGTON.

Height Above Sea Level 181 Feet.
Latitude 13° 7′ 36″ N. Longitude 59° 35′ 57″ W.

The following are the summaries of the observations recorded for the year 1938. The details are given in Appendix II.

Barometric Pressure. The records refer to observations made at the hours of 9.00 a.m. and 3.00 p.m. only and are expressed in inches of mercury. During the year 1938, the mean pressure corrected for temperature and gravity and reduced to sea-level, was at 9.00 a.m. 29.964 and at 3.00 p.m. 29.894, the highest pressure recorded being 30.072 on the 29th of March, and the lowest 29.755 on the 26th of October. For the ten-year period 1928–1937 the average barometric

pressure was at 9.00 a.m. 29.973 and at 3.00 p.m. 29.897. The highest pressure recorded at 9.00 a.m. during the ten-year period was 30.107 on the 5th February, 1932, and the lowest pressure recorded at 3.00 p.m. was 29.704 on the 30th of October, 1929.

Temperature. The daily mean maximum temperature for the year 1938 was 84.6°F. and the daily mean minimum 72.6°F. The maximum extreme for the year was 88.5°F. registered on the 18th of May and the minimum extreme was 61.5°F. registered on the 16th of February. The average monthly mean temperature was 78.6°F., the highest monthly range 25.5°F. and the lowest 15.0°F., the mean monthly range being 18.3°F. For the ten-year period 1928–1937 the daily mean maximum was 85.2°F., and the daily mean minimum 72.4°F. During the ten-year period the average monthly mean temperature was 78.8°F.; the maximum extreme was 91.4°F. on the 30th of August, 1930, the minimum extreme 63.0°F. on the 18th of February, 1932, and the average monthly range 18.3°F.

Tension of Vapour and Relative Humidity. The mean tension of vapour for the year 1938 was at 8.00 a.m. .753 and at 5.00 p.m. .735. The mean relative humidity was at 8.00 a.m. 75.0 per cent. and at 5.00 p.m. 73.1 per cent.

Wind. The daily (24-hour period) mean velocity of the wind during the year 1938 was 10.8 miles an hour. Records were kept of half-daily or 12-hour periods from 6.00 a.m. to 6.00 p.m. and 6.00 p.m. to 6.00 a.m. The maximum velocity for any such 12-hour period was 21.6 miles an hour, recorded between 6.00 a.m. and 6.00 p.m. on the 15th of March and the 1st of May and the minimum velocity was 0.5 miles an hour recorded between 6.00 p.m. and 6.00 a.m. on the 11th of December. The average daily (24-hour period) velocity for the ten years ended 1938 was 10.3 miles an hour.

Rainfall. The rainfall measured at the Government Meteorological Station during the year 1938 amounted to 84.94 inches. Rainfall was recorded on 239 days, the greatest fall being 4.23 inches on the 23rd of November. For the ten-year period 1928–1937, the average total rainfall was 51.60 inches and the average number of days annually on which rain fell was 189.

Rainfall of the Island. The average total rainfall for the year 1938 from 65 stations was 88.37 inches, being 28.34 inches above the average for the ninety-one years ended December 31, 1937, which was 60.03 inches.

BARBADOS RAINFALL

Months.
January
February
March ...
April ...
May ...
June ...
July ...
August ...
September
October
November
December
Total
Average

NAME OF STATION	No. of Stations	January		February		March		April		Ma
		Days	Inches	Days	Inches	Days	Inches	Days	Inches	Days
DISTRICT "A".										
St. Michael										
Lowlands	8	16	2·06	9	1·18	14	1·51	9	1·13	15
DISTRICT "B".										
Christ Church										
Lowlands	6	12	2·06	6	1·29	10	1·20	8	1·14	12
St. George										
Highlands	1	15	4·27	9	3·26	18	3·22	11	1·59	15
Lowlands	6	15	2·79	8	2·37	11	1·42	9	1·70	12
DISTRICT "C".										
St. Philip										
Highlands ..	2	15	2·23	5	3·03	13	1·08	9	·75	11
Lowlands .	6	12	2·30	7	2·53	10	1·08	8	1·23	13
St. John										
Highlands	5	18	3·53	10	3·14	17	2·13	11	1·94	14
Lowlands	1	10	2·59	7	1·98	11	1·44	5	·92	12
DISTRICT "D"										
St. Thomas										
Highlands	5	17	4·54	11	3·57	17	3·50	10	2·35	15
Lowlands	2	17	2·87	13	2·76	19	3·05	8	1·20	13
St. James										
Highlands ..	1	10	3·50	9	2·08	8	1·55	6	1·09	15
Lowlands	5	14	2·27	10	1·92	14	2·39	8	·93	13
DISTRICT "E"										
St. Peter										
Highlands	2	15	3·64	8	2·95	11	2·01	6	·68	13
Lowlands ...	4	14	4·17	10	2·84	11	3·04	6	·90	12
St. Lucy										
Lowlands	3	10	3·51	6	1·18	8	1·71	5	·63	12
DISTRICT "F"										
St. Joseph										
Highlands . .	4	11	4·36	10	2·78	15	2·25	9	1·51	14
Lowlands	1	11	1·78	7	2·86	13	2·55	7	1·55	11
St. Andrew										
Highlands	2	12	3·67	8	2·83	13	1·82	8	1·00	16
Lowlands	1	7	2·87	2	2·70	6	1·43	3	·44	5
Total	65	[illegible]57	62·01	155	47·25	239	38·41	146	22·68	243
Average		14	3·26	8	2·49	13	2·02	8	1·19	13

APPENDIX III

. FROM JANUARY TO DECEMBER, 1938.

y	June		July		August		September		October		November		December		Total	
Inches	Days	Inches	Days	Inches	Days	Inches	Days	Inches	Days	Inches	Days	Inches	Days	Inches	Days	Inches
2·80	19	3·66	19	5·70	23	10·22	20	10·64	19	10·66	22	20·61	21	8·69	206	78·86
3·11	15	3·55	15	5·32	20	7·98	16	10·46	18	9·02	21	20·14	19	7·34	172	72·61
4·96	19	4·49	20	7·41	21	9·54	17	9·72	21	18·19	2[illegible]	32·87	21	11·27	208	110·79
3·40	17	4·34	18	6·07	21	8·71	17	11 75	18	16 41	21	24·21	18	8·62	185	91·79
4·38	18	3·48	20	5·13	22	5·68	18	8·25	19	10·39	22	30·51	19	5·65	191	80·56
4·66	17	3·35	19	5·44	21	5 81	16	7·36	20	12·14	22	25·71	17	5·67	182	77·28
4·21	17	4·49	20	7·36	24	7 53	18	10 99	20	9·89	22	30·99	19	5·81	210	92·04
2·88	11	3·38	19	6·96	16	6·59	12	10·45	16	9·06	21	27·57	13	3·98	153	77 80
1·07	20	5·23	22	8 53	25	12·10	19	12·22	21	11·77	23	30·93	23	10·03	223	108·84
3·10	17	4·21	19	7·68	24	8·68	18	8·24	21	11·97	22	26·71	21	10·50	212	90·97
4·38	16	5·02	16	7·55	20	11·56	18	13·65	17	5 6	22	25·68	22	6·74	179	88·41
3·16	18	4·03	19	7·42	24	12·05	16	8·92	18	10·53	20	23·68	20	7·94	194	85·24
3·24	18	4·13	18	6·26	23	9·91	14	13·10	16	8·91	21	31·22	21	4·32	183	90·40
3·07	16	4·80	18	6·29	23	10·31	18	12·55	17	7·66	20	29·41	20	6·42	186	91·46
2·86	16	4·47	16	6·28	21	8·05	16	10·53	18	12·32	20	29·39	16	7·73	164	88·66
3·06	18	5·02	21	8·15	22	9·06	18	10·87	21	6·33	22	30·31	19	5·17	203	88·87
3·36	14	6·59	21	9·85	19	7·47	17	9·73	21	8·61	21	33·53	17	5·51	182	96·39
3·18	19	4·01	17	6·46	21	9·36	20	12·31	16	8·63	23	31·92	22	5·60	195	90·79
1·89	8	4·67	9	5·20	12	6 67	10	9·18	13	9·88	20	28·39	5	3·88	100	77·20
5·80	313	82·92	346	129·06	402	167·28	318	200·92	350	197·98	406	533·78	353	130·87	3528	1678·96
3·46	16	4·37	18	6·79	21	8·81	17	10·58	18	10·42	21	28·09	19	6·89	186	88·37

THE YIELD OF SUGAR CANE IN BARBADOS IN 1939.

For the past ten seasons a number of plantations have co-operated with the Department in furnishing records of the number of tons of the different varieties of sugar cane which they have reaped.

2. This year returns were received from practically every plantation in the Island. A number of plantations, however, were unable to furnish returns of the actual tonnages reaped. Returns from 229 plantations were of value for this pamphlet, and these were:—

LOW RAINFALL AREAS: 53 PLANTATIONS.

Amity Lodge
Appleby
Bayleys
Bright Hall
Bromefield & Hannays (St. Lucy)
Busby Park (St. Philip)
Callendars
Cane Vale and Maxwell
Chance Hall
Chancery Lane
Charnocks
Checker Hall
Congo Road
Coverley
Dover
Durants
East Point
Enterprise
Fairy Valley
Flatfield
Friendly Hall
Friendship (St. Lucy)
Gibbons
Glen Villa
Goodland
Graeme Hall
Harrisons
Holders
Hope (St. Lucy)
Hope and Recovery
Hopefield
Husbands
Lowland (St. Lucy)
Mangrove
Oldbury
Pollards
River
Rock Dundo
Rockless
Ruby
Seawell
Spencers
Spring Hall
Spring Villa
Trents (St. Lucy)
Union (St. Lucy)
Union Hall and Briggs
Warners
Wiltshire and Whitehaven

INTERMEDIATE RAINFALL AREAS: 109 PLANTATIONS.

Alleynedale
Applewhaites
Bagatelle
Bayfield and Mullins
Balls
Belle
Bennetts
Bentley
Blowers
Boarded Hall
Boscobel
Bourbon
Brighton
Bulkeley
Buttals
Byde Mill

Cane Garden
Carmichael
Carrington
Castle
Chapel
Clermont
Collynns
Constant
Edgehill
Edgecumbe
Farm (St. Peter)
Fairfield and Cane Garden
Fair View
Foursquare
Frenches
Forster Hall
Frere Pilgrim
Friendship
Gibbes
Glebe (St. Peter)
Government Industrial Schools
Greenland
Halton
Hampton
Hanson
Hannays and Lower Greys
Harrow
Hope (St. George)
Hillbury
Hill View
Jordans
Kent
Lamberts
Lascelles
Lears
Lodge and Farm
Lower Estate and Dayrells
Lowthers
Lowland *(Christ Church)*
Molyneux
Moonshine
Mount Dacres
Monnt Pleasant
Mount Standfast
Neils
Newton
Nicholas Abbey
Norwood
Oughterson
Palmers
Pickerings
Pine
Prior Park
Queensland and Victoria
Ridge
Ridgeway
Rowans
Sandy Lane
Searles
Small Ridge aud Hope
Society and College
St. Nicholas
Staple Grove
Springfield
Stepney
Sunbury
Trents (St. James)
Upton
Valley
Vaughans
Vineyard
Walkers (St. George)
Wanstead
Warleigh and Haymans
Warrens
Waterford
Welches (St. Thomas)
Welches (St. Michael)
Welch Town
Westmoreland
Whitehall
Windsor
Woodbourne
Wotton
Yorkshire

HIGH RAINFALL AREAS: 67 PLANTATIONS.

Andrews
Ashbury
Ashford
Auburn
Bawdens and River
Blackmans
Bowmanston
Buckden, Easy Hall and Saltram
Canefield
Castle Grant
Chimborazo
Claybury
Cliff
Clifton Hall
Colleton (St. John)
Content

Cottage
Drax Hall
Dukes and Fortress
Dunscombe
Ellesmere
Endeavour
Farmers
Fisherpond
Francia
Frizers
Golden Ridge
Groves
Guinea
Haggatts and Bruce Vale
Haynes Hill
Hillbury
Hopewell (St. Thomas)
Horse Hill
Hothersal
Indian Pond
Joes River
Kendal
Lancaster
Lion Castle and Highland
Locust Hall
Malvern
Mount
Mt. Brevitor
Mount Wilton
Plum Tree
Pool
Portland
Redland
Richmond Hill
Small Hope (St. John)
Spa and Clement Rock
Strong Hope and Cleveland
Todds and Lemon Arbor
Turners Hall
Vaucluse
Wakefield
Walkes Spring
Woodland.

3. The total area reported gave an acreage of 26,117.72 acres, made up as follows:—

	Acres	Percentage of total
Plant Canes ...	12,985.51	49.72
First Ratoons	8,981.89	34.39
Second „	3,477.36	13.31
~~Fourth~~ Third „	619.16	2.37
Fourth „	53.80	.21
	26,117.72	100.00

4. Before the beginning of the reaping season, returns of the acreages under cane, both plants and ratoons, were obtained from all plantations in the Island and a total of 34,532 acres was obtained. To this must be added 7,000 acres of peasant canes, making a grand total of 41,532 acres reaped in 1939.

5. The total crop for the season is approximately 156,243 tons of sugar or 3.77 tons of sugar per acre of cane grown.

6. The data recorded in the following variety tables do not include any individual variety from which reports of less than twenty acres have been received; they are grouped as "Other Varieties."

LOW RAINFALL AREAS: 48 PLANTATIONS.

(a) PLANT CANES.

Variety.	Acreage.	Per cent. acreage in varieties.	Total tonnage.	Tons per acre.
B. 2935	2,317.97	90.22	88,572.86	38.21
B. 726	69.74	2.71	2,400.85	34.43
B. 3013	90.50	3.52	3,152.59	34.84
Ba. 11569	31.25	1.22	1,061.24	33.96
B. 3127	24.63	.96	810.53	32.91
Other Varieties	35.20	1.37	1,000.60	28.43
	2,569.29	100.00	96,998.67	

(b) FIRST RATOONS.

Variety.	Acreage.	Per cent. acreage in varieties.	Total tonnage.	Tons per acre.
B. 2935	961.31	85.03	27,448.22	28.55
B. 726	96.50	8.54	2,394.02	24.81
B. 3013	55.25	4.89	1,474.37	26.69
Other Varieties	17.44	1.54	508.99	29.19
	1,130.50	100.00	31,825.60	

7. Records of the following varieties of a total of less than twenty acres were received from the low rainfall areas:—

B. 417	plant canes	8.00 acres
B.H.10(12)	„ „	5.50 „
Mixed	„ „	21.70 „
Ba. 11569	first ratoons	16.50 „
B. 3127	„ „	.94 „
B. 2935	second ratoons	11.00 „

AVERAGE YIELDS OF ALL VARIETIES.

	Total		Average tons per acre
	Acreage	Tonnage	
Plant canes	2,569.29	96,998.67	37.76
1st Ratoons	1,130.50	31,825.60	28.15
2nd Ratoons	11.00	246.00	22.36
Total	3,710.79	129,070.27	34.78

INTERMEDIATE RAINFALL AREA: 98 PLANTATIONS.

(a) PLANT CANES.

Variety.	Acreage.	Per cent. acreage in varieties.	Total tonnage.	Tons per acre.
B. 2935	4,802.62	64.77	188,448.98	39.25
B. 3013	503.04	6.77	18,448.35	36.66
B. 726	1,389.93	18.76	49,989.21	35.97
B.H.10(12)	417.74	5.63	16,267.74	38.95
Ba. 11569	42.00	0.56	1,515.15	36.08
Other Varieties	113.89	1.53	4,093.15	35.95
B. 3127	147.52	1.98	5,819.89	39.44
	7,416.74	100.00	284,582.47	

(b) FIRST RATOONS.

B. 2935	2,230.80	48.55	64,782.60	29.05
B. 726	1,330.12	28.95	37,823.79	28.45
B.H.10(12)	478.71	10.45	14,067.16	29.38
B. 3013	397.48	8.64	10,614.15	26.70
Ba. 11569	44.79	.97	1,353.10	30.20
Other Varieties	112.40	2.44	3,026.65	26.93
	4,594.30	100.00	131,667.45	

(c) SECOND RATOONS.

Variety.	Acreage.	Per cent. acreage in varieties.	Total tonnage.	Tons per acre.
B. 2935	432.68	38.87	12,266.30	28.35
B. 726	408.26	36.68	11,897.03	29.13
B.H.10(12)	210.11	18.88	5,416.89	25.78
Other Varieties	40.00	3.59	1,109.76	27.74
B. 3013	21.97	1.98	596.18	27.14
	1,113.02	100.00	31,286.16	

(d) THIRD RATOONS.

B. 2935	20.50	19.48	635.45	31.00
B.H.10(12)	65.25	61.99	1,533.40	23.50
Other Varieties	19.50	18.53	538.32	27.61
	105.25	100.00	2,707.17	

(e) FOURTH RATOONS.

Other Varieties	10.55	....	214.05	20.29

8. Records of the following varieties of a total of less than twenty acres and records of cane returned as "mixed varieties" were received from the Intermediate Rainfall Areas:—

Mixed varieties	—	Plant	Canes	87.22	acres.
B.891	—	„	„	5.25	„
B.381	—	„	„	6.00	„
B.3439	—	„	„	3.92	„
B.3124	—	„	„	7.00	„
B.3234	—	„	„	4.50	„
Mixed varieties	—	1st.	Ratoons	80.43	„
B.891	—	„	„	4.50	„
B.381	—	„	„	9.55	„
B.2703	—	„	„	3.82	„
B.3124	—	„	„	7.00	„
B.3127	—	„	„	7.10	„
Mixed varieties	—	2nd	Ratoons	15.25	„
Ba.11569	—	„	„	9.25	„
B.381	—	„	„	4.50	„

B.3234	— 2nd	Ratoons	7.00	„
B.2703	— „	„	4.00	„
Ba.11569	— 3rd	Ratoons	4.00	„
Mixed	— „	„	5.50	„
B.3013	— „	„	1.00	„
S.C.12/4	— „	„	9.00	„
Ba.11569	— 4th	Ratoons	4.00	„
B.H.10(12)	— „	„	6.55	„

AVERAGE YIELDS OF ALL VARIETIES.

	Total		Average tons per acre
	Acreage	Tonnage	
Plant Canes	7,416.74	284,582.47	38.36
1st Ratoons	4,594.30	131,667.45	28.66
2nd Ratoons	1,113.02	31.286.16	28.11
3rd Ratoons	105.25	2,707.17	25.72
4th Ratoons	10.55	214.05	20.29
	13,239.86	450,457.30	34.02

HIGH RAINFALL AREA: 56 PLANTATIONS.

(a) PLANT CANES.

Variety.	Acreage.	Per cent. acreage in varieties.	Total tonnage.	Tons per acre.
B.H.10(12)	1,537.34	51.23	61,929.10	40.28
B. 726	664.59	22.15	28,089.12	42.26
B. 3013	515.75	17.18	21,907.79	42.48
B. 2935	238.99	7.96	9,849.11	41.22
B. 3127	35.81	1.25	1,691.02	47.22
Other Varieties	7.00	.23	322.56	46.08
	2,999.48	100.00	123,788.70	

(b) FIRST RATOONS.

Variety.	Acreage.	Per cent. acreage in varieties.	Total tonnage.	Tons per acre.
B.H.10(12)	1,751.30	53.76	58,906.61	33.64
B. 726	967.07	29.69	33,749.79	34.89
B. 3013	311.92	9.58	10,812.94	34.67
B. 2935	212.30	6.53	7,840.83	36.93
Other Varieties	14.00	.44	616.75	44.05
	3,257.09	100.00	111,926.92	

(c) SECOND RATOONS.

B.H.10(12)	1,493.54	63.46	43,901.84	29.39
B. 726	689.63	29.30	24,452.26	35.45
B. 2935	95.75	4.07	3,113.84	32.52
B. 3013	59.95	2.55	1,946.88	32.49
Other Varieties	14.47	.62	557.21	38.51
	2,353.34	100.00	73,972.03	

(d) THIRD RATOONS.

B. 2935	318.57	61.99	8,925.53	28.01
B.H.10(12)	21.25	4.13	605.33	26.77
B. 726	160.59	31.24	5,688.49	35.42
Other Varieties	13.50	2.64	278.75	20.64
	513.91	100.00	15,498.10	

(e) FOURTH RATOONS.

B.H.10(12)	41.25	95.37	1,146.23	27.78
B. 726	2.00	4.63	53.03	26.51
	43.25	100.00	1,199.26	

9. There are three features in variety yields in this area which are of interest.

10. Firstly, the B.3013 is equal in yields to the standard B.726 both as plant canes and first ratoons, and both of them are superior to B.H.10(12).

11. Secondly, as in recent years, the B.726 is definitely superior as a ratooner to B.H.10(12), *particularly as second and third ratoons.*

12. Thirdly, the new seedling B.3127, as plant canes, out-yielded B.H.10(12) by 7 tons of cane per acre and B.726 and B.3013 by approximately 5 tons per acre. The yield of B.3127 is derived from a relatively small acreage so that the differences in yield must be judged accordingly; however, the tonnage obtained is distinctly promising and gives a good indication of its possibilities in areas suitable to its growth.

13. Records of the following varieties of a total of less than twenty acres were received from the High Rainfall Areas:—

Mixed varieties	—	Plant Canes	—	7.00	acres
Mixed varieties	—	First Ratoons	—	13.00	"
B.3127	—	" "	—	1.50	"
Mixed varieties	—	Second "	—	5.22	"
B.3124	—	" "	—	.75	"
B.3234	—	" "	—	1.00	"
B.381	—	" "	—	7.50	"
Ba.11569	—	Third "	—	13.50	"
B.726	—	Fourth "	—	2.00	"

AVERAGE YIELDS OF ALL VARIETIES.

	Total		Average tons per acre
	Acreage	Tonnage	
Plant Canes	2,999.48	123,788.70	41.26
1st Ratoons	3,257.09	111,926.92	34.36
2nd Ratoons	2,353.34	73,972.03	31.43
3rd Ratoons	513.91	15,498.10	30.14
4th Ratoons	43.25	1,199.26	27.72
Total	9,167.07	326,385.01	35.60

14. *The total average reported yields per reaped acre for the plantations* submitting returns are as follows:—

	Total		Average tons per acre
	Acreage	Tonnage	
Plant Canes	12,985.51	505,369.84	38.92
1st Ratoons	8,981.89	275,419.97	30.66
2nd Ratoons	3,477.36	105,504.19	30.34
3rd Ratoons	619.16	18,205.27	29.40
4th Ratoons	53.80	1,413.31	26.26
Total	26,117.72	905,912.58	34.69

YIELD OF SUGAR CANE PER ARABLE ACRE.

15. It is a matter of extreme interest to the planter to obtain the maximum yield for each acre planted with sugar cane on his estate, but from the economic point of view, the yield per arable acre of the whole plantation is the measure which determines whether sugar cane is being produced on an economic basis.

16. The higher rainfall areas may for practical purposes be described as the red soils and the lower and intermediate rainfall areas as the black soils in which ratooning is less extensively practised than in the red areas. The following table shows the yield per arable acre in these two areas, together with the arable acreage for all the plantations which have submitted crop returns and which may be taken as a very close reflex of the whole Island.

	Total			
	Acreage reaped	Total arable	Total tonnage	Average tons per arable acre.
Black Soils:				
(a) Low Rainfall	3,710.79	6,891.00	129,070.27	18.73
(b) Intermediate Rainfall	13,239.86	22,098.00	450,457.30	20.39
Red Soils	9,167.07	13,179.00	326,385.01	24.77
Total	26,117.72	42,168.00	905,912.58	21.48

REPORT

ON

SUGAR CANE BREEDING AND SEEDLING TESTING FOR THE YEAR 1938—39.

BY

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A. SUGAR CANE BREEDING, SEEDLING SELECTION AND TRIALS.

(i) SUGAR CANE BREEDING — B.41' SERIES.

Sugar cane breeding was carried out at Lion Castle from October to December, 1939.

2. All breeding work consisted in crossing, the usual routine lantern method predominating. A further experiment was made in the use of the Hawaiian method. This was essentially a repetition of last season's unsuccessful attempt except that this season a stronger solution was used to feed the cut arrows and the crosses being made were isolated in a humid gully exposed for a considerable part of the day to direct sunlight. This situation, it was considered, might remedy the possible defects of the old sugar boiling house used last season in that humidities and light values were higher. Six crosses were made under these conditions, but the method proved a failure, the solution under the conditions being unable to keep the parent arrows alive sufficiently long to admit of flowering and seed maturation. It would appear from these experiments that the Hawaiian method is not suited to the conditions prevailing in these experiments.

3. The fuzz from the lanterns was sown in boxes. The season was one favouring heavy arrowing and there was no shortage of material for crossing work.

(ii) SEEDLING RAISING, POTTING AND PLANTING IN FIELD NURSERY — B.41' SERIES.

4. The usual sowing and potting methods were used.

5. Sowing was done from December to January and potting during February. In March and April, potted seedlings were planted in the field nursery where they were irrigated to establish them.

6. Table I shows under group heads the numbers of seedlings germinated from the sowings, potted and planted into the field nursery.

TABLE I.*

Numbers of Seedlings in each Group Germinated, Potted and Planted in Field Nursery.

Group.	No. crosses.	No. germ-inated.	No. potted.	No. planted in field nursery.
Saccharum officinarum	18	18,097	9,852	6,516
S. spontaneum				
(i) Java 3rd nobilisation	8	1,783	1,353	1,120
4th „	11	12,794	2,985	2,132
5th „	12	2,130	1,217	868
(ii) India				
2nd „	3	1,545	1,192	1,080
(iii) Celebes				
3rd „	6	714	503	446
S. barberi				
2nd „	1	62	48	30
3rd „	2	875	677	581
S. sinense				
2nd „	3	78	57	47
Crosses involving several *Saccharum* species	14	5,192	3,267	2,632
Totals	78	43,270	21,151	15,482

7. It is to be noted that in the nursery plantings the proportion of nobilised to purely noble seedlings is almost two-thirds. This is a much larger proportion than in previous years and is due to the fact that the nobilisation work has been taken to such a stage as to provide many exceedingly promising commercial seedlings. This feature is referred to later.

(iii) PLANTING THE FIRST YEAR SEEDLING TRIAL—B.40' SERIES.

8. This series was bred in 1937, planted in the field nursery in March and April 1938 and selections from the field nursery planted in the First Year Seedling Trial in October of the year under review. This trial will be reaped in 1940. Details for each of the crosses planted are given in Appendix II. A summary of this Appendix is given in Table II below.

* Details for the crosses comprising these groups are given in Appendix 1 to this report.

TABLE II.

Numbers of Crosses and Seedlings in each Group Planted in the First Year Seedling Trial—October, 1938.

Group.	No. crosses.	No. of seedlings planted in First Year Seedling Trial—October, 1938.
Noble	7	3,540
Nobilisations.		
Sacc. spontaneum (Java)		
(a) 3rd degree	1	46
(b) 4th „	5	897
(c) 5th „	9	2,482
Sacc. spontaneum (India)		
(a) 2nd degree	1	258
Sacc. spontaneum (Celebes)		
(a) 3rd degree	1	49
Sacc. spontaneum (Java-India)		
(a) 4th degree	1	998
Sacc. barberi		
(a) 2nd degree	1	104
(b) 3rd „	2	110
Sacc. sinense		
(a) 1st degree	2	7
(b) 2nd „	1	1
Mixed Derivatives	6	725
Totals	37	9,217

9. The usual lay-outs were employed in planting this trial.

(iv) RESULTS OF REAPING FIRST YEAR SEEDLING TRIALS—B.39' SERIES.

10. These were bred in 1936, planted into the field nursery in April, 1937, and from this into the First Year Seedling Trial in October, 1937.

11. In presenting the results, the several groups are treated separately.

12. (a) *Proven and Semi-proven Crosses.* These consist of populations of seedlings derived from crosses between noble parents. These crosses have by previous test been shown to give populations of seedlings with high average values in features upon which selection is based e.g. weight and sucrose per-

centage. Each population consists of a block of seedlings, there being no longer any intention of comparing populations. The seedlings are cut, bundled and laid out for inspection and field selections made. Juice qualities are obtained by taking twelve Zeiss Hand Refractometer readings: three from each of four canes in each field selected seedling. Final selections are made when all are reaped.

13. This group is divided in (1) early and (2) late; the former comprising seedlings from parents which tend to mature early, the latter seedlings from parents which mature later. They are cut early and late in crop respectively.

14. Table III gives details of field and final selections.

TABLE III.

First Year Seedilngs, B.39' Series. Field and Final Selections from Proven and Semi-proven Crosses.

(1) Early Group.

Cross.		No. reaped	No. selected in field.	Percentage field selection.	No finally selected	Percentage final selection
Ba.11569	x B. 417	586	32	5.4	15	2.5
,,	x B.6835	298	24	8.0	4	1.3
,,	x B.6450	150	11	7.3	3	2.0
,,	x Q. 813	144	7	5.0	4	3.0
,,	x B. 693	113	8	7.1	1	0.9
,,	x B. 603	431	32	7.4	10	2.3
B.3013	x B.2935	150	20	13.3	13	8.7

(2) Late Group.

Cross.		No. reaped	No. selected in field.	Percentage field selection.	No finally selected	Percentage final selection
Ba.11569	x B.H.10 (12)	1598	55	3.4	18	1.1
,,	x Ba.8069	475	34	7.2	10	2.1
,,	x B. 603	500	30	6.0	5	1.0
,,	x B. 693	100	2	2.0	2	2.0
,,	x B.6450	152	8	5.3	5	3.3
B.3013	x B.2935	222	17	7.9	10	4.5
B.3138	x B.2935	30	1	3.3	0	0.0

15. The cross—B.3013 x B.2935 appeared to be outstanding and will have larger populations planted in future.

16. (b) *Proven Nobilisations.* These are crosses which previous tests in the experimental cross group (see below) have shown to produce seedling populations of high standard. Like the crosses in the proven cross group, the populations are planted in blocks and the selection procedure is similar.

17. Selection details are given in Table IV.

TABLE IV.

First Year Seedlings, B.39′ Series. Field and Final Selections from Proven Nobilisation Group.

Cross.	Derivation.	No. reaped.	No. selected in field.	Percentage field selection.	No. finally selected	Percentage final selection.
B.3013 x P.O.J. 2878	4th Glagah *nobilisation*	228	32	14.0	15	6.6
M.I.20 x B.6835	„ „	68	1	1.4	1	1.4
B.3172 x B.2935	5th „	83	9	10.8	5	6.0
B.3215 x B.H.10(12)	„ „	108	13	12.0	7	6.5
B.3365 x B.2935	3rd Chunnee *nobilisation*	129	16	12.4	8	6.2

18. A high occurrence of arrowing accounted for the low selections in the cross—M.I.20 x B.6835. For this reason it will be discarded. It is of interest to note the much higher percentage final selections in the other crosses noted in Table IV as compared with those in Table III. This, despite a similar selection procedure and standards being adopted in both cases. It is becoming clear that the best results are now accruing from the nobilisation work and the policy will be to extend this part of the breeding at the expense of the purely noble-cane breeding.

19. (c) *Experimental Crosses.* At present this group contains nobilised seedlings only. The object of the trial is twofold, i.e. (1) to compare crosses by comparing their progenies and (2) to provide possible commercial seedlings. With a view to rendering legitimate a comparison of crosses, any one seedling in this group is inserted at random on a plan and planted in the field accordingly. It follows that the seedlings of each and every cross are scattered throughout the test area. For purposes of camparison between crosses, for every seedling the following data is obtained at reaping:—(1) weight (2) number canes (3) length and width of an average cane (4) percentage arrowing and (5) juice brix value. The best of these crosses are subsequently promoted to the proven nobilisation group.

20. Possible commercial seedlings are also selected during reaping. In this group, 2,132 seedlings were reaped, 148 selected in the field and 59 finally selected; thus giving a 2.8 per cent final selection. The per cent final selection figures for individual crosses varied from 0% to 22%. These selection

figures for the various crosses tested are used in conjunction with the detailed data mentioned above in assessing the value of the crosses and in guiding the breeding work.

21. (d) *Early Nobilisations.* These are seedlings derived from crosses which represent first or second degrees of nobilisation of wild species.

The seedlings themselves are not expected to have any immediate commercial value, but selections are made chiefly to serve as parent material for further nobilisation work. Occasionally potential commercial seedlings are produced, but these are very much in the minority.

22. Two hundred and ninety-three seedlings derived from early nobilisations were reaped and fifteen finally selected.

(v) PROGRESS WITH SEEDLINGS OF THE B.38′ SERIES.

23. (i) *Noble Cane Seedlings.* In all, 99 of these were selected from the proven and semi-proven groups reaped during the 1938 crop. These were multiplied at Codrington Experiment Station until November when all were planted in plots at Dodds; these plots to serve for multiplication and gumming disease resistance tests. The survivors from these tests will be planted in Second Year Trials during the season 1939-41.

24. (ii) *Nobilisations.* In all, 121 nobilised seedlings were selected from the experimental cross group in 1938. These were multiplied at Codrington Experiment Station during 1938 and in October from these multiplication plots, 75 were selected and allocated to the Central Sugar Cane Breeding Station Second Year Trial at Codrington for the season 1938-40 as follows:—(a) thick-cane trial (standards—B.2935, P.O.J.2878)—43 seedlings and (b) thin-cane trial (standard—Co.213)—32 seedlings.

25. Sixteen early nobilisations selected in 1938 were multiplied during the year and planted in November at Lion Castle to serve as parents in further nobilisation work.

(vi) PROGRESS WITH SEEDLINGS OF THE B.37′ SERIES.

26. (i) *Noble-cane Seedlings.* These were selected in 1937, multiplied at Codrington and in November planted at Dodds for further multiplication, gumming disease resistance tests and minor selection.

27. Of an original total of 112 seedlings, 56 were eliminated on account of poor appearance in the field or susceptibility to gumming disease. The remaining 56 were planted in Second Year Trials for season 1938-40,—22 being placed in the early group and 34 in the late group.

28. (ii) *Nobilisations.* The selections from the multiplication plots at Codrington in October 1937 were planted in a special Second Year Trial, styled the Central Sugar Cane Breeding Station Second Year Trial. This trial was reaped in 1939. It was divided into a thick, and a thin-cane trial, the standards in the former being B.2935 and P.O.J. 2878 and in the latter, Co.213. The performances of standards and selected seedlings are noted in Table V.

TABLE V.

Central Sugar Cane Breeding Station Second Year Trial B.37' Series. (Nobilisations) Codrington 1937-39.
Performances of Standards and Selected Seedlings.
(The Figures given are Means of Four Plots).

(a) THICK-CANE TRIAL (32 SEEDLINGS TESTED)

Variety or seedling.	No. of canes.	Percentage arrowing.	Brix°	Weight tons per acre.	Significant difference in weight between plot means Tons per acre.
B. 2935	105	0	19.5	38.56	
P.O.J. 2878	152	20	20.3	37.26	
*B. 37181	155	0	19.4	55.21	
B. 37172	181	36	21.5	46.60	
*B. 37157	139	1	19.4	45.23	
*B. 3371 ...	160	3	21.2	40.60	±8.47
B. 37193	209	0	20.9	38.99	
B. 37219	130	0	20.1	37.19	
B. 37163	105	1	19.4	36.55	
B. 37154	95	0	23.2	33.60	
B. 37164 ...	118	0	20.3	33.46	

(b) THIN-CANE TRIAL (17 SEEDLINGS TESTED).

Variety or seedling.	No. of canes.	Percentage arrowing.	Brix°	Weight tons per acre.	Significant difference in weight between plot means Tons per acre.
Co. 213 ...	299	61	16.7	43.24	
*B. 37161	169	1	18.7	67.94	
B. 37175	164	14	19.4	51.21	
B. 37184	232	3	18.5	50.12	
B. 37162	230	6	15.6	49.05	
B. 37259	234	0	18.1	48.69	±7.97
B. 37174	240	31	17.3	48.62	
B. 37226	175	8	16.3	46.18	
B. 37176	225	3	17.8	43.52	
B. 37227	175	6	17.8	41.94	
B. 37224	225	25	19.7	37.49	

29. The seedlings marked with an asterisk are to be further tested under Barbados conditions in Select Seedling Trials and Maturity Experiments. All are to be planted in the breeding plots at Lion Castle to serve as parent material and also in mosaic disease resistance test plots.

30. It is evident from the data given in Table V that some of the selected seedlings are very promising for Barbados; this applies especially to B.37161 and B.37181. This Second Year Trial goes to emphasise the potential value of the nobilisation work for Barbados.

(vii) SECOND YEAR SEEDLING TRIALS—NOBLE-CANE SEEDLINGS.

31. (i) ***B.35' Series—First Ratoons.*** These were cut as plant canes at Dodds and Todds during the 1938 crop. The plots of the seedlings then selected were cut as first ratoons at Todds (the high rainfall station) during the *1939* crop.

32. The cane yields and juice brix values are given in Table VI.

TABLE VI.

B.35' Series (Noble-cane Seedlings). Cane Yields and Juice Brix Values for Standards and Selected Seedlings as Plants (1938) *and First Ratoons* (1939).

Seedling	Yield—Tons per Acre			Brix.		
	Plants (1938)	1st Ratoons (1939)	Total	Plants (1938)	1st Ratoons (1939)	Average
B. 726	35.32	46.33	81.65	22.3	22.8	22.6
B.H.10(12)	36.58	48.28	84.86	20.5	20.7	20.6
B. 3518	39.20	38.88	78.08	21.5	20.6	21.1
B. 3520	37.00	42.12	79.12	21.7	20.5	21.1
B. 3521	44.71	49.57	93.28	21.5	20.9	21.2
B. 3525	41.15	44.06	85.21	21.6	22.0	21.8
B. 3540	47.30	51.19	98.49	21.2	20.7	21.0

33. Both B.3521 and B.3540 are promising and will be further tested.

34. (ii) *B.34' Series—Second Ratoons.* These were reaped as plant canes at Dodds and Todds in 1937. In 1938 and 1939, the plots of those selected in 1937 were cut at Todds as first and second ratoons respectively.

35. The cane yields and brix values for the three crops are given in Table VII.

TABLE VII.

B.34′ Series (Noble-cane Seedlings). Cane Yields and Juice Brix Values for Standards and Selected Seedlings for Three Crops.

Group Seedling	Yield—Tons per Acre.				Brix.			
	Plants 1937.	1st R. 1938.	2nd R. 1939.	Total.	Plants 1937.	1st R. 1938.	2nd R. 1939	Average.
Early B. 726	46.98	40.18	37.81	124.97	20.20	23.50	23.40	22.37
B. H. 10 (12)	40.66	41.15	35.32	117.13	19.27	23.70	22.60	21.86
B. 3419	52.55	46.66	42.12	141.33	19.42	23.10	23.50	22.01
B. 3429	47.17	38.23	29.39	114.79	19.95	23.00	21.90	21.62
B. 3439	44.97	48.28	47.82	141.07	20.50	24.50	22.90	22.63
Late B. H. 10 (12)	43.09	42.77	34.99	120.85	22.00	23.60	23.10	22.90
B. 3461	47.21	45.36	37.58	130.15	21.20	22.80	22.10	22.03
B. 3464	61.04	48.40	45.68	155.12	20.40	20.40	21.50	20.77
B. 3479	51.55	46.00	39.85	137.40	20.50	21.90	21.60	21.33
B. 3482	49.86	37.91	28.93	116.70	21.20	22.70	22.10	22.00

36. In the above Table VII, the terms "early" and "late" under the group head mean that standards and seedlings appearing under them, were, as *plant canes, reaped early and late in crop respectively. It can be seen that in* the *early* group both B.3419 and B.3439 are appreciably superior to the standards. B.3419 is definitely promising for red soil estates. B.3439 gives very high ratoon yields. It is a rather thin-cane, erect seedling which arrows profusely. Nevertheless, it has excellent juice qualities and would appear to ratoon successfully over a long period. B.3429 was inferior to the standards and will be discarded.

37. *In the late group B.3464 gave high cane yields, but the juice quality* was poor and its canes tended to rot readily. B.3461 and B.3479 gave good cane yields but their juice qualities were poor. B.3482 was inferior to the standards. All the seedlings tested in the late group will be discarded.

38. The seedlings of this B.34′ series were reaped as plant canes in the Select Seedling Trials in 1939 and their performances are noted in the following section.

(viii) SELECT SEEDLING AND CO-OPERATIVE VARIETY TRIALS —B.35′, B.34′, B.33′, B.31′ and B.30′ SERIES.

A. *The Seedlings Tested.*

(1) *Select Seedling Trials.*

Plant Canes — B.3307, B.3419, B.3429, B.3461, B.3464, B.3479, B.3482, B.35187, B.35245.

First Ratoons — B.3013, B.3127, B.3267, B.3307, B.3327, B.3439.

(2) *Variety Trials.*

Plant Canes — B.3013, B.3127, B.3439.
First Ratoons — B.3013, B.3127.
Second Ratoons — B.3013.
Third Ratoons — B.3013.

B. *An Ecological Classification of the Trials.*

39. The classification is similar to that used in recent years and is as ollows:—

A. Black and sandy coral limestone soils where average seasonal rainfall is low. On account of low rainfall, ratooning is difficult and cane tonnages are usually low. Stations in this category were:—

(a) Select Seedling Trials.

Plant Canes: Ruby, Husbands.

(b) Variety Trials.

Plant Canes: Springhall, Balls, Grazettes, Sandford, Foursquare, Mangrove.

First Ratoons: Searles, Fairy Valley, Haymans, Small Ridge.

B. Black coral limestone soils of low-intermediate rainfall. On account of a rainfall better than that in Category A, a certain amount of ratooning is practised. The extent of ratooning would increase, were stronger ratooning seedlings available.
Stations in this category were:—

(a) Select Seedling Trials.

Plant Canes: Halton, Frere Pilgrim.

(b) Variety Trials.

Plant Canes: Bourbon, Edgecumbe, Lower Estate, Warrens.

C Valley deep black coral limestone soil area, low-intermediate rainfall. This area may suffer periodic poor soil aeration. Soils, especially sub-soils, tend to heavy texture, and root diseases are commonest here. Varieties resistant to the root disease complex are necessary here. A considerable percentage of this area is ratooned.

Stations in this category were:—

(a) Select Seedling Trials.

Plant Canes	Hampton.
First Ratoons	Bulkeley.

(b) Variety Trials.

Plant Canes	*Hannays* Constant.
First Ratoons	*Buttals.*

D. Red coral limestone area, intermediate to high rainfall. One to four ratoon crops are grown here.
Stations in this category were:—

(a) Select Seedling Trials.

Plant Canes	*Mount Brevitor* Henley *Mount* Wilton.
First Ratoons	Pool Drax Hall Rock Hall.

(b) Variety Trials.

Plant Canes	Colleton Groves Woodland Ashford.
First Ratoons	Hopewell Andrews Bakers *Locust Hall* Guinea.
Second Ratoons	Society Blowers Cliff Claybury.
Third Ratoons	Mount Wilton.

C. *Rainfall during the Season.*

40. The average monthly rainfall for season 1938–39, derived from returns from numerous plantations throughout the island, is shown below and compared with similar figures for the eighteen year period from season 1920–21 to 1937–38.

MONTH AND RAINFALL IN INCHES.

Month	Seasons.	
	1938–39	1920/21-1937/38
January	3.26	3.38
February	2.49	1.86
March	2.02	1.57
April	1.19	1.67
May	3.46	1.91
June	4.37	4.48
July	6.79	6.40
August	8.81	6.19
September	10.58	7.22
October	10.42	7.37
November	28.09	8.55
December	6.89	4.03
January	2.27	3.38
February	3.19	1.86
March	1.25	1.57
Totals	95.08	61.44

41. It can be seen that the season was one of excessive rainfall: more especially from August to December. The May and June rains following the drier months of February to April favoured heavy stooling and early growth of the shoots in the stools. From July onwards rain was plentiful, in fact excessive in November. Growth was excellent and heavy cane tonnages were reaped throughout the island. Juice ripening was slow at first but later more rapid and excellent juices were obtained.

D. *Results of the Trials.*

42. In Select Seedling Plant Cane Trials, the following routine data are obtained at each trial:—(1) cane tonnage, (2) number of rotten canes, (3) complete cane chemical analyses from a plot sample bundle from one of the plots and sucrose per cent. in juice from a sample bundle from each of the remaining

plots, and (4) a calculation of the saccharose yield per acre. Statistical analyses of cane tonnages and sucrose per cent. in juice are made.

43. In Select Seedling Ratoon Trials, cane tonnages, number of rotten canes and hand refractometer brixes are obtained.

44. In Variety Trials, cane tonnages and hand refractometer brixes are obtained.

45. The salient results are presented in a series of Figures (Figs. I—V). In these Figures are given, for plant cane Select Seedling Trials, the calculated yield of saccharose per acre and for ratoon Select Seedling Trials and Variety Trials, the tonnage of cane per acre. The small lines alongside the two last named represent established statistical significant differences in tonnages between seedlings. Other relevant data are given in the text below.

46. The results for the various categories are considered.

Category A (Fig. I).

47. In this category two plant cane Select Seedling Trials, six plant cane and four first ratoon Variety Trials were reaped.

48. In the plant cane Variety Trials the new seedling B.3439 was compared with the standard, B.2935. The figure shows, for this series of trials, that B.2935 appreciably outyielded B.3439 in cane tonnage: the actual averages for the six stations being B.2935—39.12 tons per acre and B.3439—33.40 tons per acre. On the other hand the average juice brix values were B.3439—21.2 and B.2935—18.5. With regard to cane tonnage, there can be no doubt that the unusually high and well distributed rainfall was relatively more favourable to the standard than to the shorter season type—B.3439. It is felt that with rainfall around or less than average, B.3439 would equal B.2935 in tonnage. The high juice quality of B.3439 coupled with a high fibre content are both very desirable qualities in an early variety in this category, allowing as they do an earlier start to crop and providing an adequate supply of megass for fuel. While these results are disappointing from the cane yield point of view, it is considered that a final judgment on B.3439 should await further plant cane and ratoon trials in this category.

49. In the ratoon Variety Trial, at Haymans and Fairy Valley—the drier estates—B.2935 was emphatically superior in cane yield to both B.726 and B.3127. This was also the case in the plant canes, reaped in 1938, so that, in spite of both B.726 and B.3127 having juices superior to B.2935, it can be confidently stated that the sugar yields per acre of B.2935 are greater than those of B.726 and B.3127. At the wetter stations—Searles and Small Ridge—the tonnage differences are not so marked. The average total plant cane and ratoon yields and brix figures for these two stations are given here:—

	Yields—plants plus ratoons—tons per acre.	Brix
B.2935	63.22	21.9
B.726	53.12	24.6
B.3127	54.23	24.5

50. Although it is probable that B.2935 outyielded both in sugar per acre, it would appear to be advantageous to grow a small percentage of B.726 for early reaping, at which time the juice quality of B.2935 is low and the fibre low and of poor burning quality.

FIG I. CATEGORY A.

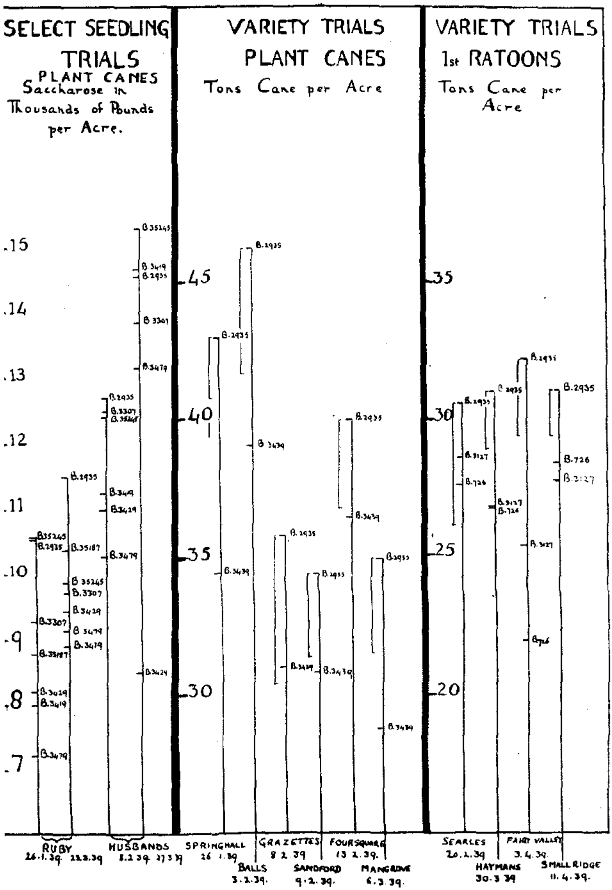
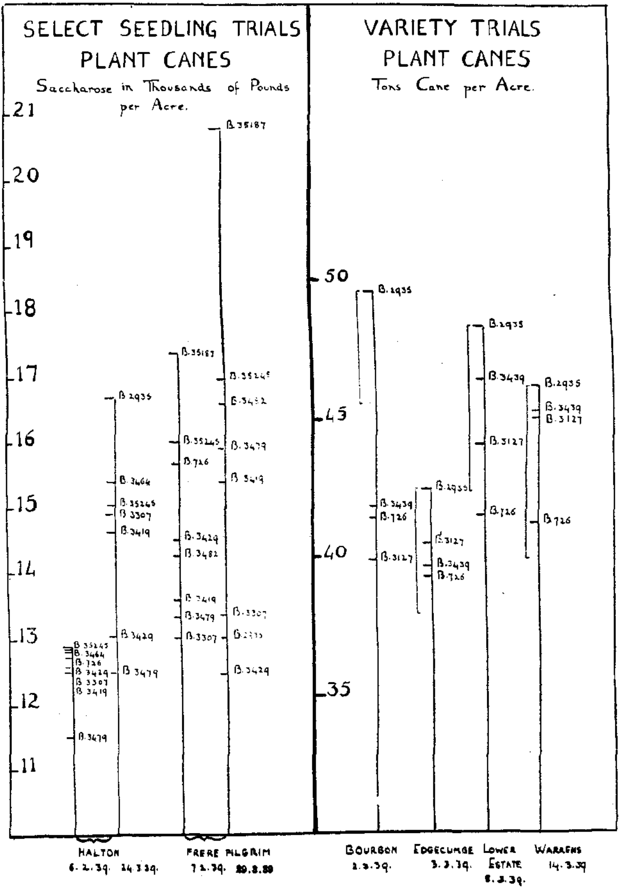


FIG II. CATEGORY B.



51. There is little to choose between B.726 and B.3127 and it seems there would be no advantage gained by replacing the former with the latter.

52. *In the plant cane Select Seedling Trials*, B.2935 was the standard. It is quite clear from the diagrams on Fig. I. that B.35245 is the only serious competitor of the standard in this category. The comparative average data of B.2935 and B.35245 for both stations are therefore given here:

Variety.	Early Reaping.				Late Reaping.			
	Yield Tons per acre.	No. rotten canes per plot.	Per cent. sucrose in cane.	Pounds saccharose per acre.	Yield Tons per acre.	No. rotten canes per plot.	Per cent. sucrose in cane.	Pounds saccharose per acre.
B. 2935	42.02	15	12.28	11,572	38.88	47	14.94	13,001
B. 35245	36.55	13	14.27	11,460	35.98	28	15.44	12,557

53. *It is seen from the above that B.35245 gives a lower cane yield than* the standard but compensates by having a very much higher juice quality, especially early in crop. Much will depend on how they compare as ratoons. B.35245 is to be tested in Variety Trials against B.2935 in Category A.

Category B (Figure II).

54. Two plant cane Select Seedling Trials and four plant cane Variety Trials were reaped in this Category.

55. In the Variety Trials, the new seedlings—B.3127 and B.3439 were compared with the standards—B.726 and B.2935. At Bourbon, B.2935 gave an emphatically superior cane and probably sugar yield. At the other stations—Edgecumbe, Lower Estate and Warrens—B.2935 yielded only slightly better than the others and the brix figures must also be considered. These were as follows:—

Station.	Brix and Variety.			
	B.2935.	B.726.	B.3127.	B.3439
Edgecumbe	18.8	22.1	21.6	20.7
Lower Estate	19.3	21.2	20.5	22.1
Warrens	20.2	22.4	22.5	22.1
Averages	19.4	21.9	21.5	21.6

56. From these figures coupled with the cane tonnages, it would appear that, *in estimated sugar yield, there was little to choose at Edgecumbe* between B.3127 and B.726, both of which probably outyielded B.3439, while all three probably outyielded B.2935. At Lower Estate it is probable that B.3439 outyielded the others which possibly yielded about the same amount of sugar. At Warrens, it is certain that B.3127 and B.3439 outyielded both B.726 and B.2935 which were probably about equal. It would appear that, under good rainfall conditions in the intermediate rainfall areas of St. Michael, St. George and

St. Philip, B.726, B.3127 and B.3439 give as good or even better sugar yields than B.2935. In lower rainfall years, however, it is probable that this would apply to B.3439 only. Both B.3127 and B.3439 tended to give higher cane yields than B.726. Much, however, will depend on ratoon yields and these will be awaited with interest.

57. In the plant cane Select Seedling Trials at Halton and Frere Pilgrim the standards were B.726 in the early and B.2935 in the late reaped trials respectively. Of the seedlings reaped at *both* stations, as in Category A, B.35245 was the most promising. B.3307, B.3419, B.3429, B.3479 were all, for one reason or another, inferior to the standards. B.3464 was reaped at Halton only. It gave here very high cane tonnages, but was very susceptible to cane rot and had very low juice quality. It is not up to commercial standard. B.3482 was grown at Frere Pilgrim only, but here was markedly inferior to the standards. B.35187 was also only grown at Frere Pilgrim in this category. Here, it gave, for this area, exceptionally high cane yields—approximately 57 tons per acre. It was, however, late in ripening. At the late reaping, when it was nearer full ripeness, it gave a calculated yield of approximately 21,000 pounds of saccharose per acre—the highest figure ever reached in comparable Departmental trials. This seedling appears to be peculiarly suited to conditions as exemplified at Frere Pilgrim and also to red soils (q.v. below).

58. To conclude this category, it may be noted that B.3127, B.3439, B.35187 and B.35245 are all promising and will be further tested.

Category C. (Fig. III).

59. In this category one each of plant cane and first ratoon Select Seedling Trials and plant cane and first ratoon Variety Trials were reaped.

60. In the plant cane Variety Trial, B.3127 at both stations was definitely superior to the standard in cane yield while the brix figures were B.726—22.5 and B.3127—22.0. In the first ratoon Variety Trial, B.3127 again outyielded B.726. B.3127 is therefore promising for valley soils. B.3439 gave only slightly better plant cane yields and was not cut as a ratoon. Nothing definite, therefore, can be stated about its value in valley soils.

61. From the ratoon Variety Trial and Select Seedling Trial, it can be seen that the yields of B.3013 are very inconsistent. From trials carried out in this category up to date, it would appear definite that B.3013 is *not* suited to *valley soils. The seedlings B.3267 and B.3327, while giving good cane yields* were appreciably inferior to the standard—B.726 in juice quality and soundness and will be discarded. B.3307 was markedly inferior and will be discarded.

62. In the plant cane Select Seedling Trial at Hampton, B.726 was standard. The seedlings, B.3307, B.3479, and B.3482 were decidedly inferior to it. B.3419 improved during crop to equal B.726 at the late reaping. B.3429 gave good cane and sugar yields but its canes are known to rot very readily and, for this reason, it will be discarded. B.35245 once again is promising. Before any definite pronouncement can be made, however, it will be necessary to get ratoon yields.

Category D. (Figs. IV & V).

63. Three plant cane, three first ratoon Select Seedling Trials and four *plant cane, five first, four second and one third ratoon Variety Trials were* reaped in this category.

64. The second and third ratoon Variety Trials represented a completion of the trials to test B.3013 against the standards—B.726 and B.H.10(12) in red soils. For this reason the results over all crops are given in Table VIII. Brix figures were obtained for the 1939 reapings only, during which year the Zeiss Hand Refractometer was used for the first time in Variety Trials.

FIG III. CATEGORY C.

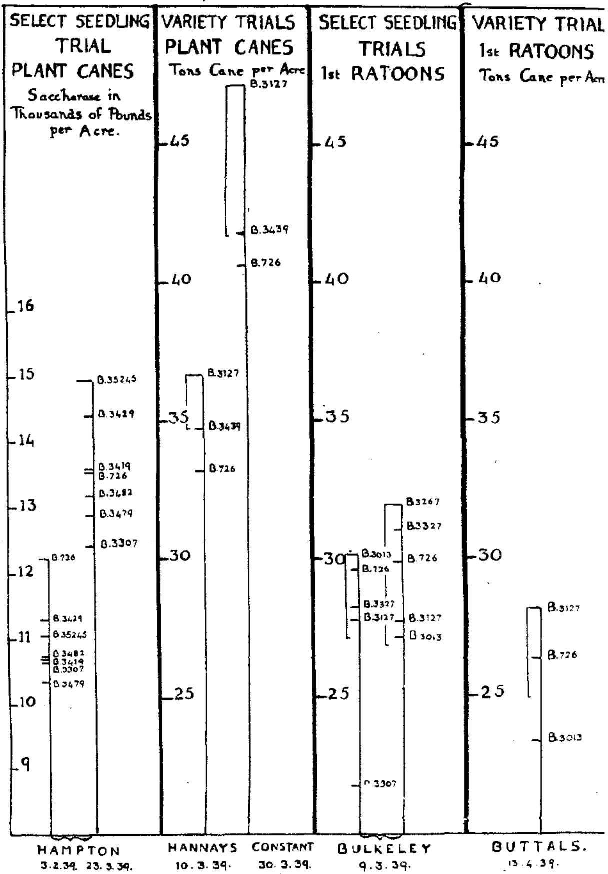


FIG IV. CATEGORY D.

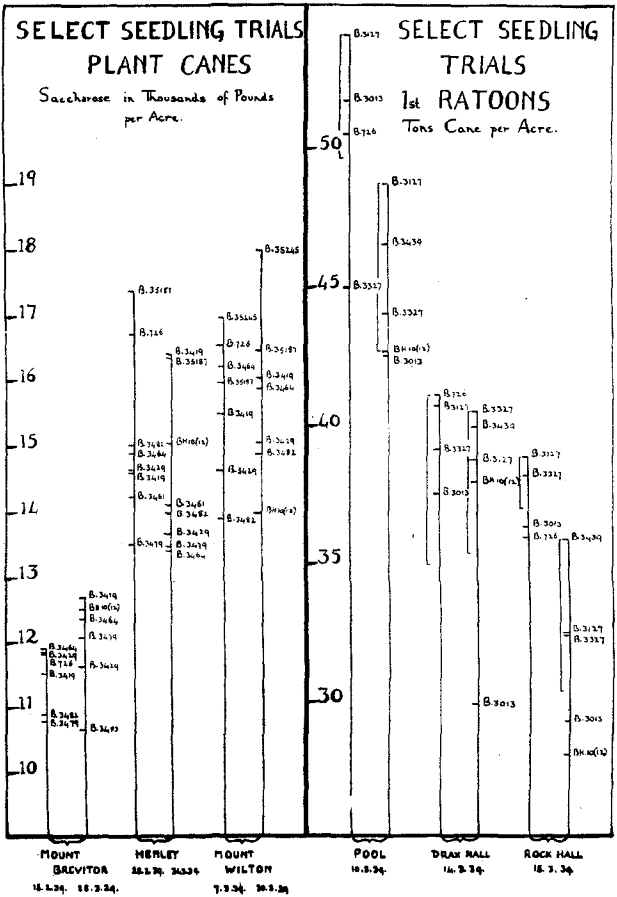


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FIG V. CATEGORY D (concld).

VARIETY TRIALS. TONS CANE PER ACRE.

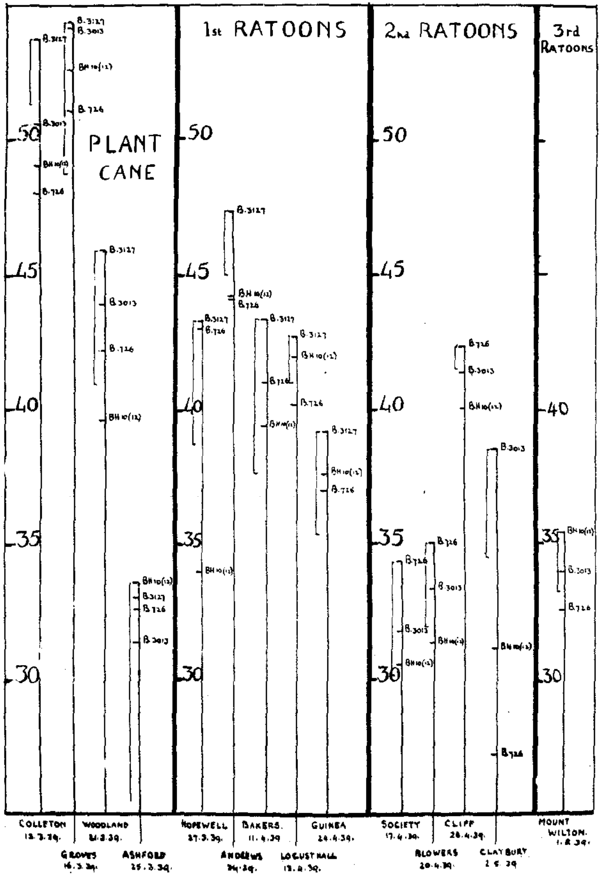

TABLE VIII.

Versus the Standards — B.726 and B.H.10(12) in Red Soil Areas — Category D.
Detailed Cane Yields for all Crops and Brix Figures for the 1939 Crop.

Variety and Yield in Tons per Acre.

		B.H.10(12).					B.3013.					Brix — 1939.		
3rd R.	Total.	Pl.	1st R.	2nd R.	3rd R.	Total.	Pl.	1st R.	2nd R.	3rd R.	Total.	B.726.	B.H. 10(12)	B.3013
....	100.74	38.55	28.24	30.51	....	97.30	35.82	26.85	31.74	....	94.41	23.7	23.5	24.2
....	109.64	43.16	34.64	31.42	....	109.22	45.19	34.21	33.47	....	113.47	23.6	23.6	23.7
....	124.73	44.49	41.52	40.07	....	126.08	50.12	41.15	41.50	....	132.77	23.9	23.5	23.5
....	103.38	41.93	35.93	31.29	....	109.15	50.05	39.70	38.62	....	128.37	24.5	23.6	24.4
32.58	143.09	38.04	39.09	37.15	35.35	149.63	40.46	44.15	38.91	34.03	157.55	23.1	21.5	23.2
32.58	116.32	41.23	35.89	34.09	35.35	118.28	44.33	37.33	36.85	34.03	125.31	23.8	23.1	23.8

65. From the above Table VIII, it can be seen that, for all estates over all reapings, B.3012 has given greater cane yields than the standards. This greater yield is sustained through plant canes, first and second ratoons. It has to be noted, however, that the relative yields of B.3013 and standards vary according to the estate. Thus, at Society, B.3013 was inferior, at Blowers, Cliff and Mt. Wilton, superior, and at Claybury, markedly superior to the standards. Experiments conducted by the Department would indicate with regard to juice features, that B.726 ripens earliest, B.3013 next and B.H.10(12) last of all and that when all are ripe their juice qualities are about equal. From all relevant tests, it would appear that B.3013 is superior to both B.726 and B.H.10(12) in the best class red soils, i.e., the highest yielding red soils.

66. The first ratoon Variety Trials were a continuation of five plant cane trials designed to test B.3127 against the standards—B.726 and B.H.10(12). It may be noted here that in the plant canes all three varieties tested gave approximately similar cane yields. From Fig. V., however, it can be seen that in the first ratoons B.3127 tends to give higher yields than the standards. This tendency is further emphasised in the results of the first ratoon Select Seedling Trials (Fig. IV).

67. In the plant cane Variety Trial B.3127 was tested against B.726, B.H.10(12) and B.3013: the last named being regarded now as a standard. (See Fig. V). Here again, with the exception of a low yielding trial at Ashford, B.3127 outyielded B.726 and B.H.10(12) and to a lesser extent B.3013.

68. With regard to juice quality, the data so far accumulated indicate that B.3127 equals B.H.10(12) both in rate of ripening and actual sucrose in juice. It is therefore apparent that B. 3127 has distinct promise for red soil areas.

69. In the first ratoon Select Seedling Trials (Fig. IV), B. 3327 gave reasonably good yields but it is not expected to come up to commercial standard. B.3439, which was in the group reaped late as plant canes, gave in ratoons very good yields, more especially at Rock Hall. The field here used was typical of certain areas in the red soils, i.e. rocky and exposed. In such conditions, B.3439, appears to perform much better than the standards and could safely be grown on a commercial scale.

70. In the plant cane Select Seedling Trials, the standards were B.726 in early and B.H.10(12) in late reaped groups. Of the seedlings tested, the following are considered inferior to the standards:—B.3429, B.3461, B.3464, B.3479, B.3482. The seedling B.3429 gives reasonably good cane yields but is extremely susceptible to rotting. B.3464 gives very high cane yields but very low juice qualities and tends to rot. B.3479 yields well but has poor juice quality. B.3461 and B.3482 are both mediocre.

71. The promising seedlings are—B.3419, B.35187 and B.35245. B.3419 appears to best advantage in the late reaping where it emphatically outyielded the standard—B.H.10(12) in cane and calculated sugar yields in two out of three trials. It would, however, appear to be inferior to B.726 in early reapings. B.35187 was tested at two stations—Henley and Mt. Wilton. Here it gave exceedingly high cane yields. Its sugar yields, however, were not so outstanding: this on account of its being a late ripener. Even at the late reapings it was far from mature. It is almost certain that if cut when ripe, it would far outyield the standards in sugar yields. This seedling is interesting in that it possesses some wild cane blood. So far, in tests in Barbados, it has proved resistant to mosaic disease. One surprising feature in view of its genealogy is that it does not arrow, even in red soils. The noble-canes grown as standards all arrow in red soils. B.35187 has been distributed to small holders in mosaic-proclaimed red-soil areas and is giving excellent results. The seedling B.35245 was tried at one station only—Mt. Wilton. Here it was first in calculated sugar yields at

both early and late reapings. This seedling has more wild-cane blood than B.35187. It is, however, susceptible to mosaic and shows the maximum allowable leaf symptoms of gumming disease. The individual canes are long and thick, the cane yields are high and the juice quality excellent early in crop.

72. The ratoon performances of both these B.35′ seedlings will be awaited with great interest.

73. All three promising seedlings have been or will he put in co-operative variety trials. The other B.34′ seedlings will be discarded.

E. Note on the Seedling Requirements of Barbados.

74. The red soils and intermediate rainfall black soils are well provided with several varieties of good calibre. There yet remains the necessity for an early ripening, strong ratooning seedling for the low rainfall black soil areas. In recent years B.3124, B.3307 and B.3439 have all been tested against B.2935 but none so far have proved better than the standard. It is the intention to test B.35245 for this purpose and a more recent seedling already referred to—B.37161.

F. Planting Recommendations.

75. These will be issued as usual to each estate and small holders' areas prior to the coming planting season. Six varieties will be recommended:—B.2935, B.726, B.H.10(12), B.3013, B.3127, B.35187. B.3127 is being recommended to Categories C and D. B.35187 is being recommended to small holders in mosaic proclaimed red-soil areas.

B. SHORT NOTE ON SPECIAL INVESTIGATIONS.

76. The results of special investigations on sugar cane are given in detail from time to time in separate publications, chiefly in Bulletins of the Central Sugar Cane Breeding Station. An outline report on these undertaken during the season under review has recently been published (Agric. Journ., Dept. Sci. & Agric., Vol. VIII, No. 2, April, 1939).

These are listed here:—

(i) Growth Measurements.
(ii) Gumming Disease Investigations.
(iii) Mosaic Disease Resistance Tests.
(iv) Investigations with the Zeiss Hand Refractometer.
(v) Sugar Cane Spacing Experiments.

77. The following publications were issued during the season:—

(i) McIntosh, A. E. S. and Stevenson, G. C., 1938. Studies in the Use of the Zeiss Hand Refractometer (3) The Zeiss Hand Refractometer as an Indicator of Ripening in Sugar Cane, B.W.I. Central Sugar Cane Breeding Station, Bulletin No. 18, June.

(ii) McIntosh, A. E. S., 1938. Sugar Cane Spacing Experiments. Journ., Dept. Sci. & Agric., B'dos., Vol. VII., No. 4, October.

APPENDIX I.

Sugar Cane Breeding, Seedling Raising and Field Nursery Planting, 1938-39. B.41' Series.

Details of Crosses Made, their Germinations, Numbers Potted and Numbers Planted in Field Nursery.

Cross.		Group.	No. Germinations Nov. 1938. Jan. 1939	No. Potted Jan.-Feby. 1939	No. Planted in field nursery
Ba.11569	x B.H.10(12) ..	*Noble S. officinarum*	3,689	2,816	1,871
,,	x B.6450	,,	260	189	129
,,	x B.603	,,	952	630	416
,,	x Ba.8069 ..	,,	2,166	1,030	789
,,	x Ba.6032 ..	,,	1,083	820	500
,,	x B.693	,,	1,015	1,020	650
,,	x B.417	,,	12	0	0
,,	x Q.813	,,	495	450	324
,,	x D.49/30 ..	,,	714	464	290
,,	x D.66/30 ..	,,	4,609	561	301
B.3439	x B.3489	,,	238	190	100
,,	x E.K.28 ..	,,	1,027	510	420
,,	x B.3127	,,	28	0	0
,,	x Ba.6032 ..	,,	187	185	150
,,	x B. 3461 ..	,,	325	245	160
,,	x B.3307	,,	1,099	674	356
,,	x B.417	,,	181	68	60
B.3138	x Ba.6032 ..	,,	17	0	0
			18,097	9,852	6,516

APPENDIX I. (*Contd.*)

Cross.	Group.	No. Germinations Nov. 1938. Jan. 1939	No. Potted Jan.-Feby. 1939	No. Planted in field nursery
	Nobilisations. S. spontaneum—			
	Java. (a) 3rd degree			
B.37276 x B.6450	„	5	0	0
B.37275 x B.2935	„	16	13	10
B.37278 x B.2935	„	75	67	60
B.37266 x Ba.6032	„	109	77	60
B.35261 x B.2935	„	31	18	10
B.3254 x P.O.J.2878 ..	„	0	0	0
B.3215 x P.O.J.2878 ..	„	1,262	1,018	880
B.35257 x B.2935	„	285	160	100
		1,783	1,353	1,120
	Java (b) 4th degree			
P.O.J.2725 x B.3464 ..	„	567	460	352
B(30)L.6 x B.3419	„	476	452	401
B.3382 x B.H.10(12) ..	„	19	0	0
P.O.J.2722 x B.2935 ..	„	177	122	100
P.O.J.2725 x B.2935 ..	„	204	180	140
B.3013 x P.O.J.2878 ..	„	663	520	470
M.D.47 x B.H.10(12) ..	„	47	46	0
B.3354 x B.H.10(12) ..	„	.7	74	60
B.3353 x B.H.10(12) ..	„	75	61	49
B.3353 x Ba.6032	„	109	70	60
B.3439 x B(30)L.7	„	10,380	1,000	500
		12,794	2,985	2,132

APPENDIX I. (*Contd.*)

Cross.	Group.	No. Germinations Nov 1938-Jan. 1939	No. Potted Jan.-Feby. 1939	No. Planted in field nursery
	S. spontaneum—Java. (c) 5th degree			
Ba.11569 x M.42 ..	.. "	33	26	18
Ba.11569 x B.35237	.. "	176	0	0
B.34123 x B.2935 ..	.. "	245	186	150
Ba.11569 x B.35176	.. "	163	0	0
B.2254 x B.2935 ..	.. "	0	0	0
B.34102 x *Ba.6032*	.. "	*116*	85	*60*
Ba.*11569* x M.28 ..	.. "	21	0	*0*
B.34106 x B.2935 ..	.. "	8	*0*	0
B.34102 x B.2935 ..	.. "	793	584	370
B.3013 x B.34110	.. "	3	0	0
B.3172 x Ba.6032	.. "	180	116	90
Ba.11569 x B.34161	..	392	220	180
		2,130	1,217	868
	S. spontaneum—India. (*a*) 2nd degree			
B.3013 x B.37253 ..	.. "	684	565	520
B.3439 x B.37252 ..	.. "	115	97	80
B.3439 x B.37256 ..	..	746	530	480
		1,545	1,192	1,080

Cross.	Group.	No Germinations Nov. 1938. Jan. 1939.	No. Potted Jan.-Feby. 1939.	No. Planted in field nursery.
	S. spontaneum— Celebes (a) 3rd degree			
B.35197 x B.6450	„	27	18	18
Ba.11569 x B.35256 ..	„	3	0	0
B.37260 x B.2935	„	343	243	190
B.35204 x Ba.6032 ..	„	284	198	149
B.37257 x B.2935	„	52	44	89
B.37258 x Ba.6032 ..		5	0	0
		714	503	446
	S. barberi (a) 2nd degree			
C.P.807 x B.H.10(12) ..	„	62	48	30
		62	48	30
	(b) 3rd degree			
Co.213 x B.603	„	14	10	10
B.3365 x B.2935	„	861	667	571
		875	677	581
	S. sinense (a) 2nd degree			
B.35271 x B.603	„	46	36	37
B.37226 x B.2935	„	32	21	10
Ba.11569 x B.35275 ..	„	0	0	0
		78	57	47

Cross.	Group.	No. Germinations Nov. 1938-Jan. 1939.	No. Potted Jan.-Feby. 1939.	No. planted in field nursery.
	Mixed Derivation			
P.O.J.2725 x B.35245 ..	„	295	250	170
B.35207 x P.O.J.2878 ..	„	1,917	550	420
B.34117 x B.2935	„	10	9	0
B.3254 x B.35269	„	3	0	0
B.35214 x B.34161	„	1	0	0
Co.213 x P.O.J.2878 ..	„	33	26	20
B.3365 x P.O.J.2878 ..	„	138	136	100
B.37263 x B.H.10(12) ..	„	43	37	30
B.3353 x Co.281	„	26	20	0
B.3365 x B.35272	„	1,909	1,580	1,322
B.3353 x B.34116	„	621	500	470
B.3353 x B.35276	„	159	140	120
Ba.11569 x C.P.28/11 ..	„	11	0	0
Ba.11569 x B.37261 ..		26	19	10
		5,192	3,267	2,662
Grand Total		43,270	21,151	15,482

APPENDIX III.

Sugar Cane First Year Seedlings—'B.40' Series.

List of Crosses and their Numbers of Seedlings Planted in the Field Nursery (April/May, 1938) and the First Year Seedling Trial (Oct./Nov. 1938).

Group.	Cross.	No. in field nursery	No. planted in First Year Seedling Trial
Noble	Ba.11569 x B.H.10(12)	2,891	1,979
Saccharum officinarum.	,, x B.603 ..	396	298
	,, x B.417 ..	55	45
	B.3013 x B.2935 ..	391	246
	Ba.11569 x B.6835 ..	1,499	849
	,, x Q.813 ..	42	33
	B.3439 x B.H.10(12)	125	90
		5,399	3,540
Nobilisations: Saccharum spontaneum Java:—			
(a) 3rd degree ..	B.35261 x B.2935 ..	72	46
(b) 4th degree ..	B.3013 x B.3337 ..	614	306
	B.3274 x B.H.10(12) ..	161	103
	P.O.J.2722 x B.H.10(12)	79	60
	M.D.47 x B.H.10(12) ..	425	378
	B.3392 x B.603 ..	82	50
(c) 5th degree ..	B.3013 x B.34161 ..	101	56
	B.3013 x B.35176 ..	79	60
	B.3013 x B.34134 ..	565	201
	B.3172 x B.2935 ..	265	212
	B.3371 x B.2935 ..	72	56
	B.3215 x B.H.10(12) ..	2,736	1,554
	B.3238 x B.2935 ..	309	228
	B.34137 x B.2935 ..	72	53
	B.3348 x B.2935 ..	109	62
		5,741	3,425
Saccharum spontaneum Celebes.			
(a) 3rd degree ..	B.35197 x B.2935 ..	78	49
		78	49

APPENDIX II.—(*Concluded*).

Group.	Cross.	No. in field nursery	No. planted in First Year Seedling Trial
Saccharum spontaneum India.			
(a) 3rd degree ..	B.3013 x B.35251 ..	366	258
		366	258
Saccharum spontaneum Java—India.			
(a) 4th degree ..	B.3238 x B.35253 ..	1,939	998
		1,939	998
Saccharum barberi			
(a) 2nd degree ..	B.3013 x P.O.J.234 ..	186	104
(b) 3rd degree ..	B.3013 x B.35245 ..	60	49
	Co.213 x B.603 ..	79	61
		325	214
Saccharum sinense.			
(a) 1st degree	Uba x B.H.10(12) ..	3	2
	Kavangire x B.H.10(12)	5	5
(b) 2nd degree ..	C.H.64/21 x B.H.10(12)	1	1
		9	8
Mixed Derivations.	B.3013 x B.35196 ..	150	93
	Ba.11569 x B.35276 ..	9	8
	Co.213 x P.O.J.2878	15	11
	B.3439 x Co.290 ..	328	251
	B.3439 x B.37261 ..	414	275
	C.P.807 x B.3337 ..	144	87
		1,060	725
	Grand Totals ..	14,917	9,217

INTRODUCTION OF DRY AREA RACE OF METAGONYSTYLUM MINENSE INTO BARBADOS.

BY

R. W. E. TUCKER, M.A., B. Ed.

The stated policy of Barbados in regard to the control of the small moth borer of sugar cane, *Diatraea saccharalis,* has always been the combination of large scale annual, but seasonal, liberations of artificially reared egg parasites, *Trichogramma minutum* in conjunction with endeavours to establish introduced larval parasites.

2. The introduction of the larval parasite, *Lixophaga diatraea* in 1930 was not successful, and this was ascribed to the inadequacy of the material introduced and liberated.

3. In 1934-35, this parasite was again introduced, propagated in large numbers by laboratory methods and colonised to the extent of ten thousand mated females and over five thousand males.

4. Despite the complete adequacy, for the size of the Island, of the colonisation, field recoveries were few, and by 1936 it was evident that this parasite had failed to establish itself. This was fully confirmed in 1939 by the large-scale operations to obtain *D. saccharalis* larvae for the laboratory propagation of *Metagonystylum minense;* in these operations, no *Lixophaga* whatever were recovered.

5. The introduction of *Metagonystylum minense* from the shores of the Amazon river in Brazil to British Guiana, and subsequently from British Guiana to St. Lucia, Antigua and Puerto Rico, was watched with interest.

6. This riparian strain, known as the Amazon Fly, is now reported as successfully established in British Guiana and in St. Lucia, but as having failed in Antigua and also in its first large scale introduction to Puerto Rico, though it is still being artificially reared and distributed in the latter country (1).

7. The writer's views on parasite introduction were expressed in 1935 (4) as follows:— "The study of insects is showing increasingly that variations in microclimate—not only temperature and humidity, but rate of evaporation, vapour tension, barometric pressure and air movement, as well as of macroclimate and of light intensity and numbers of light hours per day, etc., all have their effect on insect physiology, mating habits, fecundity and mortality, and one therefore becomes less and less disposed to predict what an insect will do in a new environment. When this is applied to the delicate relationship existing between two insects, as in the case of biological cont ol, one is still less inclined to predict whether a successful biological measure in one area or country will be equally successful elsewhere."

8. For these reasons, and in view of the fact that the main Puerto Rican cane area, and Antigua, in which the Amazon River strain of *M. minense* has not been so far successful, are closer in their resemblance to Barbados conditions than are British Guiana and the St. Lucia cane growing valleys, no attempt was made to introduce the Amazon strain of *M. minense* to Barbados.

9. The discovery by Dr. S. C. Harland of a different strain of *M. minense* in the Sao Paulo State of Brazil (3) and its adaptation to rainfall conditions which were more like those of the drier West India Islands, such as Barbados, made the introduction of this new melanic strain appear desirable.

10. Though this introduction would still be on an empirical, non-predictable basis, it appears to be highly probable in view of the successful transference of the wet area strain to two new regions that the dry area strain might be successfully transferred to Barbados.

11. This project was, therefore, submitted in 1938 and approved. The total cost was estimated at £500, including mass rearing work in Barbados, and this sum has proved fully adequate. At the end of March, 1939, the writer left for Brazil to effect the introduction.

12. It must be stated that though the project was sanctioned in 1938, a start could not be made until March, 1939 for two reasons. The first was that the writer did not consider introduction advisable until the 1939 ripe crop had been removed by reaping, for it was no use establishing the parasite as a beginning in a crop about to go through the crushing mills, nor was it of much use to try and establish it in the new crop until the latter was sufficiently developed to provide shelter, light intensity and host population requisite to secure the field propagation of the fly.

13. These conditions would not exist in their optimum until from June onwards in a year of normal rainfall; hence the delaying of operations until March, 1939. With delayed rain, as has happened in 1939, suitable conditions did not start to exist until late August, and even then the drought growth of the canes, described later, made October, 1939, the earliest period of apparently really suitable conditions.

14. The second reason for waiting for the 1939 ripe crop to be fully reaped was the necessity for obtaining the annual counts of borer damage and prevalence in this crop, free from the complication of a newly introduced larval parasite.

14a. The results of the 1939 crop analysis thus obtained, give nine consecutive years of results obtained on a standardised and adequate basis, of the effect of progressively increased mass liberation of *T. minutum* on the borer infestation of the sugar cane crop.

15. If this period of nine consecutive years (plus two previous years non-standardised results) can be considered as taken over a sufficiently long period of years to allow for normal oscillation of populations, then not only may the conclusions regarding the use of *T. minutum* in Barbados be accepted as correct, but the line of proof may now be considered complete.

16. These comparable results over nine consecutive years are shown in the form of graphs and are briefly reviewed in Barbados Journal of Agriculture, Vol. 8 No. 2.

17. This digression has been necessary, not only to indicate the reason for the time chosen to introduce the new larval parasite but to state that it is definitely a fulfilment of an established programme, i.e., a co-operation with *Trichogramma* liberations and not a substitute for that work. In accordance with the *D. saccharalis* control programme, however, *Trichogramma* work will be discontinued at any future time should control by *M. minense* prove so effective that additional control is superfluous.

ITINERARY.

18. A full Itinerary is given in Appendix I. The writer landed in Rio de Janeiro on April 6th, arrived in Campinas, Sao Paulo on April 9th, visited the

State Experimental centres at Piracicaba, Jahu, Pindorama and Ribeiraopreto from April 12th to April 15tb, and resumed work at Campinas on April 17th.

19. Headquarters were at Campinas until May 12th, at which date the work was left in charge of a trained assistant, Miss Rita Atteck and the writer returned to Rio de Janeiro and travelled thence to Vicosa in the state of Minas Geraes, where arrangements had been made for obtaining what was expected to be a different strain of *M. minense* from that region.

20. At Campinas, laboratory accommodation was provided by Dr. S. C. Harland at his large and well equipped cotton research laboratory. Supplies of infested cane were obtained from the Sugar Cane Experiment Station at Piracicaba; for the cutting of this cane, and its transport to Campinas by rail and car, also for much free labour and transport, the writer is greatly indebted to the Brazilian Government through the Director of the Instituto Agronomico, Campinas, and to Dr. S. C. Harland.

21. At Vicosa, in the state of Minas Geraes, accommodation was provided by Dr. J. B. Griffing, Director of the Escola Superior Agricultura, and for his assistance, and for the help given by members of the Faculty, particularly by Dr. T. Snipes, the writer is greatly indebted.

22. From Vicosa, a visit was paid to the sugar estate Ana Florencia, at Ponte Nova, about two hours distant by car, but though much cane was examined, and a student left there for two additional days to search for *M. minense*, no infestation was found comparable with that in the cane grown on the estate of the Escola Superior: operations were therefore confined to Vicosa.

23. There were no facilities for rapid transport of puparia from Vicosa, and no time to undertake laboratory rearing of *M. minense*, hence field material only was collected, kept in cold storage, and then taken by the writer for despatch by aeroplane from Rio de Janeiro on Monday, May 29th.

24. The writer sailed from Rio de Janeiro for Trinidad on May 31st, with a stock of field parasitised *Diatraea* larvae and arrived in Barbados by aeroplane from Trinidad on June 8th.

CLIMATE AND ENVIRONMENT.

25. The principal consideration governing the introduction of the Sao Paulo strain of *M. Minense* into Barbados was the reported similarity in average annual rainfall. Owing to unforeseen circumstances, records of annual rainfall in that region of Brazil were not obtained. Detailed records of daily temperature over a period of three years were, however, kindly supplied by Dr. S. C. Harland.

26. Taking temperature records together with environment, and assuming that annual rainfall is approximately the same, namely from 50 inches (average for the coastal area of Barbados) to 70 inches (average for the central hillier regions) there are many differences which may be, on the balance, unfavourable to the establishment of this parasite in Barbados.

27. In the first place, rainfall is seasonally the opposite to that in Barbados, and the hot wet season in Barbados is the cool dry season in Sao Paulo. This was, of course, known prior to visiting the country, but other conditions which, in their sum, may prove too widely different from Barbados conditions, were not known and could only be ascertained by personal observation.

28. In the second place, the range of temperature is much greater. This also would be expected in contrasting a vast continental region with a small tropical island.

29. Taking a series of daily temperature records for three years, the minimum temperature recorded in Campinas, Sao Paulo was 13° C or 55.4° F., and the maximum 36° C or 96.8° F: a range of 23° C. or 41.4° F. Taking a similar range of records for Barbados, the minimum temperature over a similar 3 year period was 63° F., but as there is only one record of 63° F., but several of 64.5° and 65.0° F., it is reasonable to take 64°F. as a minimum temperature; the maximum for the three year period in Barbados is 89° F: the range is thus 25° F, compared with a range of 23° C. or 41.4° F. in Campinas.

30. Theoretically, this reduction of extremes should be an advantage, since *M. minense* is known to extend over a wide area of the South American continent, and has adapted itself to divergent conditions so thoroughly that the Sao Paulo strain is readily distinguished by sight from the Amazon strain. The two strains, however, have mated readily in captivity in Barbados.

31. Neither the change in rainfall season, nor the very appreciable difference in temperature range is held to be so adverse to a successful transference as the wide difference found to exist in environment and in air movement.

32. The question of light intensity, which has always been known to be an important factor in the successful mating of tachinid flies, was not investigated, because it is largely an attribute of environment, since the vegetative growth of cane fields or natural cover, will presumably automatically provide the correct light intensity at some period of the day, and the fly will adjust itself to this condition when it occurs.

33. Environment and air movement are the deciding factors in Barbados, because, compared with the Brazilian area traversed by the writer, there is too little alternate shelter—including alternate host plants—and far too much air movement in Barbados.

34. The first factor confines the introduced fly entirely to cane fields in Barbados, and the difference between the constant high winds experienced in Barbados (the healthy Trade Winds) and the preponderating periods of dead calm or moderate breezes which impressed the writer in Brazil, are most marked. The lack of high winds was commented upon, and it was gathered that the comparative atmospheric stillness commented on was usual.

35. These two factors, namely long periods of high winds and lack of shelter are held to be decisive and inimical factors.

36. In Barbados, these two inimical factors unfortunately occur together, and there is a period of at least two months (in a favourable rainy year) to four months (in an unfavourable dry year) in which there is no cane at all of sufficient height or density of growth to provide shelter or requisite shade, and during which period Trade Winds blow with refreshing steadiness for human comfort, but it is considered, making the sparsely grown canefields far too windswept for the well being of tachinids.

37. To this adverse combination must be added the fact that the tachinid population will, at that period, be reduced to an annual minimum by the reaping and crushing of the entire ripe cane crop; also the host population of *Diatraea* larvae is at its lowest, and there are no alternate hosts or host plants available, to give the fly a breeding refuge.

38. This environmental condition is so different from that found in Brazil (and noticed previously in Puerto Rico) that it may well explain the absence of larval parasites in Barbados.

39. In the region of Brazil which was travelled over, and presumably in other countries where larval parasites of *D. saccharalis* flourish, there are alternate grass hosts of *D. saccharalis*, abundant shade and shelter near to cane fields, and in Brazil, overlapping cane ripening and reaping periods and areas.

The fly *M. minense* can thus 'circulate' from cane to cover and alternate hosts and from cane to cane. In Barbados, which is only 166 square miles in extent, planted at one time and reaped at one time, circulation is stopped by an almost complete break of from two to four months, during which period the parasite must be hard put to maintain itself at all. A favourable year of early rains and quick cane growth to take the place of reaped cane, will help *M. minense* to carry over should it become permanently established; but a year of continuous low rainfall with resultant sparse cane growth, will, in conjunction with high winds and lack of alternate hosts or shelter prove exceedingly detrimental to its survival.

40. Such unfavourable conditions indisputably occur in Barbados but, whilst capable of reducing a tachinid fly to impotence or extinction, do not, unfortunately, cause more than a temporary fluctuation in the prevalence of and damage caused by *D. saccharalis*.

MATERIAL OBTAINED FOR INTRODUCTION.

41. The introduction of *M. minense* has been carried out on a more comprehensive scale than any other introduction made up to the present, in that three strains and two "acclimatisations" of *M. minense* have been used.

42. Of the strains used, two are quite definite, namely, the Sao Paulo (Campinas) strain and the Amazon strain. The strain obtained from Minas Geraes (Vicosa) may be different, inasmuch as the country is more mountainous, but actually Vicosa, from where it was obtained, is only around 200 miles in a direct line from Campinas in Sao Paulo: also, as will be stated later, the Vicosa introductions were field material, and no longer exist in Barbados as a separate strain.

43. The "acclimatisations" used were the British Guiana Amazon strain from the Vieux Fort area (owned by Barbados) of St. Lucia, and the Amazon strain obtained from British Guiana by Dr. K. Bartlett, of the Mayaguez Station in Puerto Rico and colonised in Puerto Rico and the Sao Paulo strain also obtained at Campinas by Dr. Bartlett and colonised in Puerto Rico.

44. The material from Vieux Fort, St. Lucia, was obtained by Mr. H. Manning who spent some weeks on the Vieux Fort Estate, and the material from Puerto Rico was obtained through Dr. K. Bartlett, by the kind permission of the Government of the United States of America. Reciprocal exchanges of colonies bred in Barbados were made with Dr. Bartlett.

45. The liberations in Barbados thus consist of pure Sao Paulo strain Barbados Sao Paulo crossed with Puerto Rico Sao Paulo, Sao Paulo females presumed mated with male Minas Geraes strain, Sao Paulo strain crossed with St. Lucia Amazon strain obtained originally from British Guiana, and with Amazon strain also from British Guiana acclimatised in Puerto Rico, and crosses between these two Amazon "acclimatisations".

46. The differences between the wet area Amazon strain as received in Barbados and the dry area at Sao Paulo (Campinas) strain, are discernible mainly as colouration and fecundity. There is also a general impression given of slightly greater size and robustness on the part of the wet area strain: but individual variations in size are considerable in both strains.

47. On the point of colour, the dry area variety has clearer light grey wings and an entirely black abdomen: the wet area variety has smoky brown tinged wings, and a reddish brown tinge in the abdomen, particularly laterally and ventrally. Some wet area flies bred had a slight tendency towards melanism.

48. The cross between the St. Lucia and Sao Paulo (Campinas) strains was intermediate in colouration; the wings were tinged brown near to the body, but were clearer and greyer than in the St. Lucia wet area strain, whilst the abdomen was almost entirely melanic. There exists, however, a range in colouration as well as in size in the crosses made which prevents more than a generalisation in writing. In practice, strains and crosses can be distinguished by trained observers.

49. Fecundity appears greater in the wet area strain than in the dry area according to the number of maggots available for inoculation on dissection of the flies. For laboratory routine purposes both wet and dry strains were dissected on the tenth day after mating and it is possible that the wet area strain matures more quickly and thus has more living maggots available on the tenth day.

50. Variations in the time taken to reach maturity after mating are noticeable in both wet and dry strains, as are variations in size and colour.

51. It is also possible that acclimatisation, should any of these strains or crosses become established, will produce local adaptations in colour, size, etc.: trained laboratory workers will be available to determine which, if any, strain or cross survives.

52. A total of 7,559 mated females, of all strains and crosses, were liberated in Barbados in 1939, together with 3,495 males so there can be no question of the adequacy of the colonisations. Liberations were continued in January, 1940. Owing to late rains in October, conditions of cane growth and humidity were apparently quite suitable for establishment from November, 1939, onwards.

53. In addition to these introductions of *M. minense*, the writer brought back a considerable stock of *Paratheresia diatraea* (Tns.) from Sao Paulo and Minas Geraes, but found that this genus and species was not so amenable to laboratory rearing owing to the difficulty of getting the females to mate, and the difficulty of keeping them alive after mating until the gestation period had progressed sufficiently to enable the flies to be dissected for the artificial inoculation of *Diatraea* larvae.

54. The difficulties of "nursing" a fly of this nature, in addition to the handling of the different strains and crosses enumerated above were too great, particularly as the routine work of rearing over 300 millions of *Trichogramma* was still being carried out as usual. Hence the laboratory stock of *P. diatraea* could not be maintained, and the final stock of four females and eleven males was liberated in September, three months after introduction from Brazil.

55. The technique of introduction from Campinas, Sao Paulo, was as follows:—

56. Headquarters were established at Dr. S. C. Harland's Cotton Laboratory on the Fazenda Santa Eliza, which was the experimental estate of the Instituto Agronomico of Campinas. There was sufficient cane and corn on this Fazenda for laboratory work, but not enough to provide regular supplies of material for dissection for the purpose of obtaining stocks of *M. minense*. Cane for this purpose was obtained at the Sugar Cane Experimental Station at Piracicaba, two hours away by motor car, but also part of the Instituto Agronomico. For regular supplies of cane from this station, the writer is much indebted to Dr. José Aguirré at Piracicaba.

57. This infested material was dissected at the Cotton Laboratory, and the material sorted out into *M. minense* puparia, partly mature and mature *D. saccharalis* larvae and young larvae, and *D. saccharalis* pupae.

58. The *M. minense* puparia were sorted out each day for empty or damaged puparia, and for hyper-parasitised puparia. The sound puparia were put in tubes plugged with damp sphagnum moss at one end, and cotton wool

at the other, dated, aud accumulated day by day. With practice it became possible to sort out and discard the majority of hyper-parasitised *M. minense* puparia and to detect the *D. saccharalis* larvae which were parasitised by *M. minense.*

59. During the thirty days in which work was in progress in Campinas, a total of 3,458 recoveries were recorded: a recovery in this case being an *M. minense* pupa or a stage of *D. saccharalis*: actually, more were obtained, but as the workers discarded anything which they damaged whilst cutting the cane pieces open, such damaged material was not recorded. It was noticeable that very few *D. saccharalis* pupae were obtained: the major portion of the *D. saccharalis* found was in the larval form, and quite 35 to 40 per cent. of the larvae were too small to be parasitised.

60. This has to be taken into consideration when determining the percentage parasitism by *M. minense,* for at Vicosa, where relatively few small larvae, but a majority of medium to large larvae were found, parasitism was higher, whilst at Ponte Nova, two hours car drive from Vicosa, the cane examined there was more mature, had principally emerged *D. saccharalis* pupae, empty borer tunnels or very young larvae indeed, and consequently no worth while parasitism by *M. minense.*

61. The parasitism recorded at Campinas was 546 out of a total of 3,458, or 15.8 per cent.: the highest count in any one day was 26.4 per cent. and the lowest was 5.1 per cent. This includes parasitism by *Paratheresia diatraea,* of which no separate records were kept; the proportion of *P. diatraea* to *M. minense* may, however, be that recorded later, namely, 23 out of 93, or 24.7 per cent. of recorded parasitism. It also includes hyper-parasitised material: no separate records were kept of this either, inasmuch as some cases of hyper-parasitism did not show themselves by the hatching of the hyper-parasites for anything up to three weeks after storing the pupae.

62. The rate of parasitism at Vicosa was much higher, giving an average of 29.6 per cent., with the highest record 44.4 per cent. and the lowest 16.6 per cent.

63. The accumulated puparia of *M. minense* at Campinas were expected to provide an adequate number of flies for mating within six or seven days, whilst the *Diatraea* larvae obtained were maintained in jars of cane tops and pieces of split cane, in readiness for inoculation with grubs obtained from the mated flies after maturation.

64. Two difficulties, however, at once arose: the first was the extremely slow emergence of the flies and initial preponderance of males, and the second was the length of the maturation or gestation period.

65. Thus, although a stock of nearly 200 field puparia of *M. minense* was soon accumulated, the emergence of flies averaged only one per day, and the first fifteen emergences were males. It was not until seventeen days after the first *M. minense* pupae were obtained and stored in tubes for hatching that a female emerged, and was mated, and it took another seven days to obtain an absolute minimum number of six or seven mated females, from which to inoculate larvae in order to obtain hyper-parasite free puparia of known pupation dates, for mailing to Barbados.

66. It was found that some field puparia took from two to three weeks in the laboratory to hatch into flies, and it can only be concluded that the slow, irregular hatchings from the hundreds of field puparia accumulated was a climatic adjustment to the current early winter conditions: there had, in fact, been one very cold spell before this work started, and one was experienced during the work. This may also account for the lengthened gestation period, which was found to be ten to eleven days and not six to seven days as had been anticipated.

67. This long drawn out process of obtaining mated females naturally caused a heavy accumulation of *Diatraea* larvae which had to be stored and fed ready for inoculation, and many hundreds had to be discarded.

68. From these stored larvae, however, 93 hyper-parasite free fly puparia were obtained in the laboratory, of which 70 were *M. minense* and 23 were identified as *Paratheresia diatraea* puparia. These were mailed to Barbados in three weekly consignments. The delays experienced also prevented the writer from leaving on the date arranged, and a stay of another month became necessary; it was then decided to visit Minas Geraes as well as Sao Paulo State.

69. To obtain the necessary time in Vicosa, Minas Geraes, the final stages of dissecting the last five mated flies (which nevertheless constituted the bulk of the matings) were left to Miss Rita Atteck, a trained and capable assistant of Dr. Harland who had acted as laboratory assistant and interpeter to the writer for some weeks. Miss Atteck carried out the inoculations successfully and sent a total of 190 laboratory reared puparia safely to Barbados.

70. This arrangement gave the writer a clear eleven days at the Escola Superior Agricultura, Vicosa, Minas Geraes, where arrangements had been made with the Principal, Dr. J. B. Griffing, for accommodation and supply of material.

71. The supply of canes at the Escola was limited, but carried, as has been stated above, an excellent infestation of *M. minense* and *P. diatraea* at the right stage: a visit to a large sugar estate at Ponte Nova nearby showed that the infestation was not at the right stage, and no adequate supplies of parasites could be obtained there.

72. The time available was obviously far too short for laboratory rearing of hyper-parasite free puparia, so reliance had to be placed on field material, carefully sorted over for hyper-parasitised puparia.

73. This material had to be stored during the above period in a refrigerator, and then packed in an ice flask for the journey to Rio de Janeiro, and for the week end there, and then mailed to Barbados.

74. A small amount of hyper-parasitised material got through in this way, but strict precautions were taken in mailing and on receipt in Barbados, and no hyper-parasites are known to have escaped.

75. The material from Vicosa, Minas Geraes, consisted of 145 puparia of *M. minense* and 70 puparia of *Paratheresia diatraea*: that is 35.2 per cent. of the recorded parasitism was *P. diatraea*. The writer also brought over 100 field parasitised *Diatraea* larvae from Vicosa in the split pieces of cane, but the heat experienced in transit and in Rio de Janeiro, and the difficulty of providing adequate ventilation for this material, resulted in the pieces of cane 'sweating' and developing a heavy growth of mould, and in the disappearance, possibly by cannibalism, of many of the larvae. The puparia so obtained, 43 in all, were mainly *P. diatraea*, only 13 out of the 43 being *M. minense*; the pupae of *P. diatraea* are quite distinct from those of *M. minense*. The total *M. minense* puparia from Vicosa was thus 158 and of *P. diatraea* 109.

76. It was noticed in this instance, and in handling and obtaining puparia from infested canes, that *P. diatraea* puparia were more robust and less easily damaged than *M. minense* puparia.

77. There also appeared to be less hyper-parasitism, and fewer 'dead' puparia, in the case of *P. diatraea*, whilst the fly itself was more robust.

78. Nevertheless, *M. minense* had a much higher rate of field parasitism than *P. diatraea*, in the material examined by the writer even at Vicosa, where more *P. diatraea* was obtained than at Campinas. It is possible that the reluctance to mate, except under conditions which could not be ascertained in the laboratory with the restricted material and time available, is a contributory cause to this secondary position.

79. The establishment of *P. diatraea* would have been accomplished had it been found possible under the conditions of the present introduction, but there is reason to think that *M. minense* freed of its hyper-parasite, will be a more successful parasite of *D. saccharalis.* Moreover, published records to date of introduction of various species of *Paratheresia* into various American and Caribbean areas do not inspire any great hope for success in the use of introduced *Paratheresia* species.

80. The following Table gives the total introductions of *M. minense* and *P. diatraea* into Barbados and the various breeding stocks obtained.

TABLE I.

Material Received in Barbados.

Locality.	Species.	No. of Puparia	Origin.	Treatment.	Flies Hatched.	Mı
Campinas, Sao Paulo	*M. minense.*	190	Entirely laboratory.	No. Refrigeration	81 males. 59 females.	Norı
do. ...	*M. minense.*	70	Field parasitised, laboratory reared.	No. Refrigeration	39 males. 11 females.	Norı
Vicosa, ...	*M. minense*	158	Field puparia.	Refrigerated.	8 males 4 females.	I Ma
Campinas, Sao Paulo	*P. diatraea.*	23	Field parasitised, laboratory reared.	No. Refrigeration	Total of 9 both sexes.	Diffi
Vicosa, Minas Geraes	*P. diatraea.*	109	Field puparia.	Refrigerated.	28 males. 21 females.	Diffi
St. Lucia	*M. minense.* (Amazon strain).	35	Field puparia.	No. Refrigeration	11 males. 8 females.	Nor
Puerto Rico	*M. minense.* (Sao Paulo strain).	Adult Flies.	Laboratory.	Shipped as mated flies.	24	
Puerto Rico	*M. minense.* (Amazon strain).	Adult Flies.	Laboratory.	Shipped as mated flies.	22	

It will be noticed that in all cases males preponderated in the hatch of flies: in the case of *M. minense* from Brazil, males constituted 68.3 per cent. of the total.

SHIPMENT OF MATERIAL.

81. The normal pupal period of *M. minense* is from seven to eight days, and shipment must be completed within this period unless refrigeration is resorted to. As stated, the cold weather experienced at times in Campinas, extended this period, and it was possible to get a trial shipment through without pre-cooling.

82. Trial shipments of pupae obtained in the laboratory from field parasitised larvae were packed in ointment tins with adequate moisture, between layers of paper and cotton wool, and taken from Campinas to the city of Sao Paulo, and sent by aeroplane from there to Trinidad via Rio de Janeiro by Pan American Planes.

83. At Trinidad, Dr. F. J. Pound kindly took charge of each consignment and transferred it either to the K.L.M. plane service to Barbados, or in the cool store of a fast ship, according to which was due to reach Barbados first. All mailings and arrivals were notified ahead by cabling.

84. This transference from Campinas in Sao Paulo State to Barbados had to be accomplished in under eight days.

85. With field puparia, the difficulty arises that their age is unknown when they are obtained: they may be due to hatch in two or three days time, there is also the difficulty of eliminating hyper-parasitised material. Field material was, therefore, only used when there was no time to obtain anything else, as at Vicosa, in Minas Geraes.

86. *Puparia obtained in the laboratory from larvae parasitised in the field*, were of known dates, and free from hyper-parasites: as they had to be accumulated for a week prior to shipment, however, refrigeration was found to be necessary. Nevertheless, after the third shipment, on which occasion 30 per cent. of the flies hatched *en route*, colonies were successfully raised in Barbados from material obtained and sent in this manner. The bulk of the material sent to Barbados was obtained from *Diatraea* larvae inoculated with maggots from flies bred and mated in the laboratory, by which means large numbers of puparia are obtained at one time of known age when sent, and free from hyper-parasites.

87. The field material obtained at Vicosa was stored as obtained, in a refrigerator, transported to Rio de Janeiro in a flask of ice, packed as usual in ointment tins (in this case the tins were well sealed with adhesive tape because of hyper-parasitism) and sent direct from Rio to Trinidad by Pan American aeroplane and then by K.L.M. plane to Barbados. The sealed tins were opened in a large breeding cage with fine linen sides, illuminated on the far side only, and containing an effective atmosphere of ether. It was thus hardly possible for hyper-parasites, if any had hatched *en route*, to escape. The pupae were then stored in the usual tubs, normally opened at both ends, but now plunged at one end with damp megass, and at the other with cotton wool.

88. If hyper-parasites appeared subsequently in such tubes, (which were stored in a breeding cage as above), the cotton wool plug was moistened with ether or chloroform, and the hyper-parasites safely removed into tubes of alcohol. If flies had also hatched in the same tube, they were naturally chloroformed as well, but on removal were given a chance of recovery.

89. Any discarded puparia after each day's examination were destroyed in boiling water.

90. Although the field material sent up in this manner was edequate for starting a colony, it was not possible to rear a separate *M. minense* strain from Vicosa, because the flies would not mate. They were given the same treatment exactly as the Campinas flies which were mating readily and were also given

many variations of the treatment. Nevertheless, though one female from Vicosa lived for 38 days and another for 25 days, and all were supplied with Campinas males as well as their own males, they did not mate. On dissection at death, they were all sound organically, with well developed ovaries, but infertile. The only explanation appears to be that the refrigeration period affected their reproductive capacities.

91. Males of *M. minense* from Vicosa were placed with Campinas Sao Paulo, females, and it is thought that this cross may have been effective: but as Campinas males were also put in to avoid any loss of the then available Campinas females, the cross cannot definitely be confirmed, because there was no ascertainable difference in appearance between the Vicosa and Campinas strains.

92. In addition to the introductions made from Brazil by the writer, exchange of mated female flies of the Sao Paulo strain, obtained by Dr. K. A. Bartlett from Campinas about a month prior to the writer's visit, was effected, and also an exchange of the Amazon variety from British Guiana colonised in Puerto Rico and sent to Barbados, and the same variety colonised in St. Lucia, transferred to Barbados from Vieux Fort and sent from Barbados to Puerto Rico.

93. These exchanges of from 22 to 24 females each time were sent in tins with gauze screened ventilation apertures, and containing a removable wide mesh wire framework, through which were inserted dental cotton rolls carrying moisture and sugar solution. Each tin was wrapped in a band of wet cloth, covering the ventilation apertures and then in a wrapper of cellophane and the tins packed in cotton wool, packaged and sent by airplane via Trinidad.

94. The transferences were successful and out of 46 flies sent as above 9 survived to their dates of dissection. Apart from the different strains and 'acclimatisations' so obtained, the wider breeding stock thus obtained greatly lessened any inbreeding.

95. Once again, Dr. F. Pound of the Department of Agriculture, Trinidad, acted as receiver, and transferred all consignments from Pan-American to K. L. M. planes and *vice versa*, and opportunity is taken here of acknowledging the very useful services which he has rendered in this work.

RECEPTION AND HANDLING OF MATERIAL.

96. The material from Brazil was received in Barbados by Mr. C. C. Corbin, assistant to the writer. Mr. Corbin had previous experience in the laboratory rearing of *Lixophaga diatraea* when that parasite was bred by the thousands in Barbados and was fully capable of taking all precautions against hyper-parasites, as previously mentioned, and of initiating the laboratory breeding routine.

97. The co-operation of the planters was obtained to send in regular and organised supplies of dead hearts and young cane damaged by *Diatraea* larvae: a supply of between 200 and 300 larvae daily being aimed at.

98. The requisite amount of field material was sent in, but owing to prolonged lack of rainfall in 1939, during what should have been the wet season, a large proportion of the *Diatraea* obtained was in the pupal stage, or in a larval diapause stage. The latter stage was very disconcerting because such larvae pupated soon after being disturbed, with the result that large numbers of laboratory inoculations of such larvae failed, because pupation occurred before the *M. minense* maggots placed on them could effect an entry, or, if entered, could develop sufficiently to stop pupation of the *Diatraea* diapause larvae.

99. The result was a disheartening low percentage of successful inoculations. (*See Appendix II.*)

100. After a time, diapause larvae were recognised and discarded, and all larvae were dipped in saline solution before inoculation in order to facilitate entry of *M. minense* maggots, and more maggots per larvae were used. **Also,** one or two days of rain, though inadequate for the cane crop as a whole, produced more normal *Diatraea* larvae. The result was a satisfactory increase in percentage recovery of *Metagonystylum* puparia, and a satisfactory output of mated females for colonisation.

101. The prolonged dry weather was also having an adverse effect on the adult flies in the laboratory, and on his return from Brazil, the writer found that mortality was far too high: this was overcome by keeping the cages containing mated flies continuously covered with two layers of wet sacking, thus providing increased shade and moisture.

102. A temporary set-back was also experienced at first, due to irregularities in the time at which mated females were ready for dissection. This was a serious matter at first when only a few females were available and a certain amount of experimenting was necessary to determine the correct stage of development. The fly *M. minense* is oviparous, not larviparous, but the larvae hatch from the egg almost immediately after it is deposited. It was necessary, therefore, to test each female by putting it in a tube with a smear from the body juices of crushed *Diatraea* larva: if the female was ripe, it oviposited and could be used the same or the next day for dissection: alternatively, females were left until they showed signs of dying, and were then dissected, but even so, some females went fifteen days, and then, when dissected, contained very few, or even no living maggots, though fertile.

103. When laboratory reared stocks became adequate, experimentation was dropped, and the flies were dissected on their 11th day, and finally the 10th day was adopted as the routine. More flies were used in this way, but the results were far more satisfactory.

104. With these adaptations, no further difficulties were experienced, and laboratory rearing proceeded normally, resulting, as has been stated, in the breeding of 23,779 females and males as recorded in Appendix II.

DIATRAEA SPECIES.

105. At one period, the low percentage of laboratory recoveries from inoculated larvae, and the high percentage of *Diatraea* which pupated after inoculation, raised the question of the presence in Barbados of *Diatraea canella,* which is not very susceptible to parasitism by *M. minense.* The increased ratooning in Barbados was also an added cause for suspecting that this species might possibly have appeared.

106. Large numbers of adult moths, pupae and larvae were available for examination, but the writer could find no resemblance to descriptions of *D. canella,* despite the wide variations in *D. saccharalis* which are usually encountered. To confirm this, specimens of *D. canella* were obtained from Trinidad through the kind offices of the Director of Agriculture. It is now definite that *D. canella* does not at present exist in Barbados, and that the only species that can be identified is *D. saccharalis.*

FIELD COLONISATION.

107. Liberations of parasites were made almost entirely in fields of plant cane. The most forward or well grown fields were selected as offering the greatest shade and shelter, and, wherever possible, fields were selected for comparative abundance of *D. saccharalis.*

108. Liberations were placed at fairly regular intervals over the whole Island, and all types of environment offered by the nature of the country were chosen, namely, fairly flat, continuous expanses of cane: fields with adjoining gullies or hillsides, offering a little natural shade and shelter, and fields in irrigated areas.

109. Liberations were, of course, made equally in the wet, hilly areas as in the dry coastal areas, and fields in which liberations were made were "reinforced" at requisite periods with fresh laboratory flies.

110. The normal rainfall of Barbados is considered to approximate that of the relatively dry, cane growing area of Brazil from which the melanic or dry area strain was obtained. The rainfall for the period of liberation in Barbados, however, was so far below normal that it was at times difficult to find fields with adequate growth to warrant liberations. Moreover, in many fields, the stunted low rainfall cane growth is heavily "booted": that is, the growth between cane nodes is so short, and the drying of the bases of cane blades is so premature, that the cane blades do not fall away from, or off, the cane stem, leaving cane surface exposed, but remain "booted" to the stem. The canes are thus encased in a sheath of dead and dying blades which harbours moth borer but, one would imagine, renders the work of the fly in getting to the bored stems rather more difficult.

111. Each colony liberated consisted of 40 to 50 mated females and a dozen or more males.

112. At first the mated females were kept in the laboratory for 9 or 10 days and only liberated when nearly ready to oviposit. In such cases, the cane stems were stripped to find fresh *Diatraea* borings, and the flies placed on the fresh frass: in many cases, oviposition followed at once. The procedure, however, became impossible when liberations became larger and more frequent, and by far the greater number of flies were liberated two days after mating, thus giving them 7 or 8 days in the fields to mature and find the hosts themselves.

RECOVERIES.

113. It is now considered axiomatic that if an introduced parasite is going to establish itself successfully, it does so easily and rapidly and demonstrates its capacity to control the pest in a comparatively short time.

114. Clausen has stated (2) "the difficulties experienced in securing estab-
"lishment serve as a criterion upon which the final value of the parasite may
"be judged."

115. In the present case, it has been pointed out that there is in Barbados a period each year of from 2—4 months in which conditions of high winds, little or no shelter, and minimum abundance of host, combine to render things very difficult for the tachinid parasite. When endeavouring to establish the parasite, therefore, the introduction was timed to avoid this period, and so give a maximum chance for initial success. This endeavour has, in part, been frustrated by the adverse conditions described of low rainfall and sparse and "booted" growth of cane which was prevalent in most areas of the Island up

to October, 1939: even so, the numbers of mated females liberated, and the liberation areas chosen, should have secured establishment.

116. Nevertheless, field searches at the end of September and up to December, 1939, have not shown a sufficient abundance of established *M. minense* to enable either the flies or their puparia to be found, and the dissection of hundreds of thousands of bored shoots and canes sent in by planters for the supply of *Diatraea* larvae resulted in the recovery of only three *M. minense* from the large amount of material thus obtained.

117. Systematic searches by dissection will be made at reaping period in 1940, and in the young canes of 1940, but as there has been no rapidly demonstrated control, the expectation of future results is not great.

SUMMARY.

1. The melanic dry area variety of *M. minense* was obtained in Sao Paulo State, Brazil, in April and May, 1939, shipped to Barbados by aeroplanes, bred there in the laboratory, and adequate colonies liberated from June onwards, at the best time of year for establishment.

2. The wet area strain from British Guiana, colonised in Puerto Rico and St. Lucia, was obtained from these two Islands, and also the dry area strain acclimatised in Puerto Rico: mutual exchanges of material were made with Puerto Rico. Crosses between strains were made and liberated.

3. The parasite *Paratheresia diatraea* was also introduced from Sao Paulo State to Barbados, but was not sufficiently amenable to laboratory rearing to be handled at the same time as *M. minense*, and the rearing of the normal 300 millions of *Trichogramma minutum*.

4. The methods used and results obtained are described.

5. Conditions of introduction are described and reasons given for considering that environment and winds in Barbados are not favourable for the permanent establishment of tachinid larval parasites of *D. saccharalis*, even if initial establishment by colonisation is secured.

6. In the present case, adequate initial establishment does not appear to have been obtained, but final judgment will not be made until the dissection of adequate samples of the present crop, and new crop, in 1940.

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APPENDIX I.

Itinerary.

March	29th	Sailed from Barbados in s.s. "Brazil."
April	6th	Arrived in Rio de Janeiro.
"	9th	Arrived in Campinas, State of Sao Paulo.
"	12–15	Visited Piracicaba, Jahu, Pindorama and Ribeiraopreto Experiment Stations returning to Campinas on the 15th.
" to May	16th 12th	At laboratory on Fazenda Santa Eliza, Instituto Agronomico, Campinas.
May	12th	Left for city of Sao Paulo, Sao Paulo, and thence by 'plane to Rio de Janeiro.
"	15th	Left for Escola Superior, Agricultura, Vicosa, State of Minas Geraes.
"	16th	Arrived at Vicosa.
"	18th	Visited sugar estates at Ponte Nova.
"	27th	Left Vicosa for Rio de Janeiro.
"	28th	Arrived in Rio de Janeiro.
"	31st	Sailed for Trindad per s.s. "Argentina."
June	7th	Landed in Trinidad.
"	8th	Landed in Barbados per K. L. M. 'plane.

APPENDIX II.

Summary of Laboratory Records of M. minense to end of 1939.

118. In the course of large scale laboratory breeding operations with an introduced parasite such as *M. minense*, certain interesting facts are accumulated which are worth placing on record.

119. They are as follows:—

The total number of larvae and pupae of *D. saccharalis* which were obtained from field material from the 1st of July to 31st December, 1939 for breeding *M. minense* in Barbados, was 55,839. This does not include preliminary work prior to July 1st, nor subsequent breeding work in 1940; it is therefore a conservative statement to say that 60,000 *D. saccharalis* were removed and destroyed by artificial means from the 1939-40 crop. There is no known reason which would have prevented this 60,000 from hatching into *D. saccharalis* moths, of which it is reasonable to consider that 30,000 would have been females. The *rate of egg deposition is considered to be at least 200 eggs per moth: hence*, even allowing for early larval mortality, it would appear that the removal of 60,000 *D. saccharalis*, and the prevention of their normally surviving offspring, should have some effect on the infestation of and damage to the 1939-40 crop, quite apart from any additional effect caused by the possible establishment of the parasite bred on these artificially removed *D. saccharalis*.

120. This aspect of artificially rearing an introduced parasite of *D. saccharalis* on its own host is not mentioned with any frequency, but in long continued parasite breeding operations, using a field host, the field effect may quite well be noticeable. This particular method of reducing a field infestation of *D. saccharalis* is, however, not recommended as an economic measure, nor one to be adopted permanently.

121. The next interesting fact obtained from the laboratory records is that, in addition to the *55,839 D. saccharalis* larvae and pupae, there were 1,837 larvae parasitised by the fungus *Cordyceps*. This gives a percentage *Cordyceps* parasitism in Barbados of 3.19 per cent. which, though fairly high for Barbados, is low in comparison with *Cordyceps* parasitism of around 20 per cent. which occurs, for example in Antigua.

Ratio of Males to Females:

122. Other interesting facts are, that from July 1st to December 31st, 1939, 9,283 female *M. minense* flies were bred and 14,496 males. Thus, out of a total of 23,779 flies bred, only 39 per cent. were females and 61 per cent. were males; it will be recalled that, at the foot of Table I, page 121 the percentage of males in imported material was 63.3 per cent.

Number of Flies:

123. The total of *23,779 flies* was obtained from *30,704* puparia, which is an average hatch of 77.4 per cent; naturally, some individual hatches reached much higher figures. The 30,704 puparia were obtained from 33,171 larvae inoculated, which is an average recovery of 92.5 per cent. Peak recoveries, detailed below, reached over 135 per cent. It has been stated that figures given are to December 31st, 1939: the figures for inoculations, however, stop at December 22nd, 1939, because inoculations subsequent to that date would not hatch until 1940, and are, therefore, not included in this record.

Inoculations:

124. The inoculation figures provide further points of interest. There was, as has been stated, a difficult period of very poor recoveries from inoculations,

owing to the prevalence of diapause larvae. During a period, for example, from the end of June to around the end of July, records show recoveries such as:—

191	larvae inoculated,	40	puparia recovered.
53	,, ,,	8	,, ,,
165	,, ,,	10	,, ,,

125. Average 136 larvae inoculated, 19 puparia recovered: that is 14 per cent. recovery.

These were low records: the very best records for the same period were:—

118	larvae inoculated,	158	puparia recovered.
143	,, ,,	132	,, ,,
133	,, ,,	122	,, ,,

126. Average 131 larvae inoculated, 137 puparia recovered: that is 104.5 per cent. recovery.

127. In sharp contrast to these records, are those obtained when the diapause period was over, when larvae were dipped in saline solution before inoculation, and when *D. saccharalis* larvae from corn, instead of from cane, preponderated, and when from 3 to 4 fly maggots per *Diatraea* larva were used in place of 2 to 3 per larva as before. For this period the lowest records were:—

200	larvae inoculated,	187	puparia recovered.
265	,, ,,	242	,, ,,
263	,, ,,	243	,, ,,

128. Average 243 larvae inoculated, 224 puparia recovered: that is 92 per cent. recovery and the highest records were:—

280	larvae inoculated,	503	puparia recovered.
154	,, ,,	292	,, ,,
181	,, ,,	299	,, ,,

129. Average 208 larvae, 365 puparia recovered, that is 175.5 per cent. recovery.

130. The latter records, and there are many such, are remarkable, and resulted in the average for a period of six weeks at this stage of operations being:—

281 larvae inoculated per day, 361 puparia recovered: that is 128.5 per cent. recovery.

131. The average for the period July 1st to December 22nd was:—

218 larvae inoculated per day, and 202 puparia recovered; that is 92.6 per cent. recovery.

132. This average recovery figure of 92.6 per cent. over a period of nearly six months, including the *Diatraea* diapause period shows that the rearing technique was efficient.

133. It has been stated that some increase in recoveries obtained may be attributed to the practice of dipping *Diatraea* larvae in salt solution prior to inoculation, and to using 3 to 4 maggots in place of 2 to 3 maggots per larva when inoculating, also that *Diatraea* larvae from corn may have given better results than similar larvae from cane, though field observation in Brazil did not by any means support this idea. Taking all these factors into consideration, there is no doubt that the exceptionally poor recoveries obtained in July (and in June also) were due to a preponderance of diapause larvae produced by prolonged low rainfall conditions.

Distinct Strains and Crosses:

134. It has also been stated that various distinct strains and crosses of *M. minense* were liberated in the field.

135. The numbers of these strains and crosses are as follows:—

136. *Sao Paulo (Campinas)* or dry area strain: this includes Sao Paulo material obtained direct from Brazil and Sao Paulo material obtained from Puerto Rico. Breeding was carried out from both sets of material, and crosses between them were effected, resulting in a total of 4,928 mated females and 8,029 males of the dry area strain being bred. There may be some Minas Geraes dry area crosses in this material but, as stated previously, the Minas Geraes material could not be established in the laboratory as a separate strain, and crosses on the male side were not proved.

137. *Amazon strain:* obtained from St. Lucia originally, *via* British Guiana: 1,747 mated females and 2,655 males.

138. *Amazon strain:* or wet area strain, obtained from Puerto Rico originally, *via* British Guiana. Number bred—873 mated females and 1,278 males.

139. *St. Lucia Amazon Strain crossed with Sao Paulo Strain*—1,541 mated females and 2,230 males. This cross appeared to be the most vigorous of all races or crosses.

140. *Puerto Rico Amazon Strain crossed with Sao Paulo Strain*—194 mated females and 294 males.

141. The total bred is thus 9,283 females of all strains and crosses, and 14,496 males, or 23,779 in all, as recorded above. These records are for 1939 only: very considerable numbers, additional to above, were bred and liberated in 1940 and will be recorded when the work is finally closed.

Liberations:

142. The numbers liberated in cane fields totalled 7,539 mated females and 3,495 males up to December 30th, 1939.

143. The difference in the two sets of figures is accounted for by mated female flies used for dissection to provide maggots for inoculations, and by death in captivity which, as recorded earlier, were heavy during the initial stages of laboratory work, but negligible after the first few weeks.

144. The field liberation of males is small, because only mated females were liberated in the fields, and the males liberated were laboratory surpluses liberated in preference to destroying them, and also because the records quoted definitely indicate that a preponderance of males is a necessity for *M. minense*.

Paratheresia diatraea:

145. The records for *Paratheresia diatraea* are as follows:—

Total number of *Diatraea* larvae inoculated	73
„ „ puparia recovered	64
„ „ flies bred out	46

146. This should have sufficed for adequate laboratory rearings, but, as has been stated, undivided attention could not be given to this fly, and no method could be discovered of inducing it to breed on an adequate scale in captivity, and as a result the final stock of 4 females and eleven males was liberated in September, 1939, three months after introduction from Brazil.

Rearing D. saccharalis larvae:

147. An interesting side line was the laboratory rearing of *Diatraea* larvae for inoculation purposes. This work was started in September, 1939; moths were reared from *Diatraea* pupae obtained from field material, and were left to mate and to oviposit in laboratory cages. From eggs so obtained, larvae were reared, but special conditions were not provided, nor was special attention given to the work. Nevertheless, by the end of December, nearly 200 *Diatraea* larvae had been reared, of which 96 were inoculated with *M. minense*, some had pupated

whilst still too small for inoculation, and the remainder had not reached inoculable size by the end of December.

148. The experiment was purely a side line, carried on in spare time, but as a record that *D. saccharalis* larvae can be obtained in this manner and converted into *M. minense* it may have some interest.

149. Sections of corn stalk provided the most suitable medium for rearing the larvae, and present records indicate that, for the conditions under which this work was carried out, an average of 8 weeks is taken to reach the final larval instar stage: this is much longer than for normal field conditions, and, with pupations at immature sizes, indicates unfavourable experimental conditions.

150. This work will be put on a proper basis early in 1940 and an attempt will be made to maintain *M. minense* in the laboratory entirely independently of field material.

THE TERMITES OF BARBADOS.

BY

R. W. E. TUCKER, M.A., B.Ed.

151. In common with all tropical countries, Barbados has a termite problem.

152. It is not, however, a major problem economically, though it was evident to the writer on arrival in Barbados in 1938, that damage, and therefore loss, due to termites was present. At that time, termite damage was seldom reported. The replacement of timbers in buildings, necessitated by the presence of "wood ants" was carried out and no mention made. Similarly, termite damage in cane fields, though frequently noticed by the writer, was very rarely a matter on which advice or assistance from the Department was sought.

153. It was, therefore, difficult to arrive at any estimate of the prevalence of, or damage caused by, a hidden pest such as termites, except by a thorough examination, carried out by an officer putting in full time on the work: and that at the time was not possible.

154. Investigations were devoted primarily to damage caused by termites to Government buildings and to losses suffered in cane fields, and the need for a more complete examination of the termite problem in Barbados was stressed.

155. In 1936, a full time but temporary worker on termite investigations was appointed under the direction of the writer.

156. The duties of the officer employed were to examine buildings, cane fields and, where necessary, ships' cargoes for wood ants: to collect material at each examination, exterminate termite nests where found, carry out control measures where nests could not be discovered, and report in writing on each building, field or ship examined.

157. Priority was given to the Government Bonds and to other Government or public buildings.

158. These reports enabled the Department to work in conjunction with the Public Works Department in putting termite control and preventive measures into practical operation in all public buildings due for or needing repairs. It also enabled a survey of termite damage in cane fields to be started, and some check to be maintained on the entry of termites, though, so far, only inter-Island schooners carrying firewood have been examined.

159. In addition, the services of this officer, styled the Wood Ant Inspector, were available to owners of private houses and offices, etc., on the payment of £2. 2. 0. By this means, the application of termite control and preventive measures is being demonstrated in a practical manner to all who need assistance in the control of wood ants, and the extent of accumulated and potential damage from these hidden pests is being brought home to the community.

160. This is an important practical aspect of any termite control problem.

161. At the same time, adequate collections of termites are being made in Barbados, and these are submitted from time to time to Dr. A. M. Adamson, of the Imperial College of Tropical Agriculture in Trinidad, who is working on the termites of the West Indies. The results of identifications so obtained are detailed below.

162. With the growing realisation by the public that termite damage could be, and should be, controlled, various commercial preparations for killing wood ants, and preserving timbers against their attacks, appeared on the

market. These preparations have been tested by the Department in order that any recommendations made for the use of any of these may be valid.

163. The standard treatments of zinc chloride (5% solution in water) for wood which is to be painted, and creosote for external or unpainted timber, have always been recommended.

164. The nature and extent of termite infestation in Barbados is thus being worked out, and at the same time practical control measures are being carried out, and advice on preventive measures promulgated.

165. Sufficient work has now been carried out to enable a brief survey to be made of the termite situation in Barbados.

SPECIES OF TERMITES IN BARBADOS.

166. All specific determinations of termites in Barbados have been made by Dr. A. M. Adamson of the College of Tropical Agriculture, Trinidad, who is working on the termites of the West Indies.

167. In nomenclature, Adamson follows Emerson, who gives full generic rank to many of the groups of termites often named as subgenera, such as *Cryptotermes*.

168. Thus the name *Cryptotermes brevis*, Walker is used throughout instead of *Kalotermes (Calotermes) brevis*. *Nasutitermes costalis*, Holmgren is used in place of *Eutermes costalis*.

169. The species identified from Barbados by Dr. Adamson are:—

KALOTERMITIDAE.

Cryptotermes brevis, Walker.
Kalotermes spp. May be one or more new species.
Neotermes, sp. May be a new species.
Cryptotermes sp. May be a new species.

RHINOTERMITIDAE.

Heterotermes tenuis, Hagen
Coptotermes havilandi, Holmgren

TERMITIDAE.

Nasutitermes costalis, Holmgren.

170. Of the above species *Coptotermes havilandi* causes the most severe local damage. and appears to be spreading in Bridgetown. It is an Asiatic species, and its occurrence in Barbados is interesting. *Heterotermes tenuis* is slightly more widely spread in Barbados, but does not cause such severe local damage. *Cryptotermes brevis* is the ubiquitous dry wood termite causing moderate but fairly widespread damage and *Nasutitermes costalis* occurs throughout Barbados and causes noticeable economic loss in canefields described later.

171. Concerning the identification of the Asiatic species *Coptotermes havilandi*, Holmgn., Dr. Adamson writes (2) "The genus *Coptotermes* is probably the most destructive among termites in most parts of the world, especially in Asia": and concerning the specimens from Barbados he says "I have not yet determined the species represented by these collections, but they are distinct from the only three species known to me in the New World, namely *C. testaceous*, *C. crassus* and *C. niger*. It seems unlikely that the relatively meagre fauna of

Barbados should include a peculiar species of a genus so poorly represented in other parts of the New World. If it proves to be an immigrant from the Old World, it will be difficult to explain how it reached Barbados without having been established and detected elsewhere. The question of its origin in Barbados is of great interest and economic importance and it is to be hoped that it will be further investigated soon. Of most immediate importance is probably a survey to determine the extent of its occurrence in Barbados."

172. The identification of this species as *C. havilandi* by Prof. A. E. Emerson, of Chicago, to whom Dr. Adamson sent the specimens, is of considerable interest and the following extract from a letter written by Emerson in April, 1939, to Adamson should be placed on record.

173. "The vial from Barbados proved a difficult case to run down. I think I finally have the correct determination, though the species is only known from the imago, and the soldiers from the original locality should ultimately be compared in order to verify the determination. The vial is labelled 'Barbados, B.W.I. 11, 1937 from R. W. E. Tucker, Baggage Warehouse.' The imago compares exactly with a ? Paratype imago of *Coptotermes havilandi*, Holmgren, from Saida, Malacca, 1886, Mus Wien 72. This species was described from imagoes from Hinlap, Siam, which is the type locality. Holmgren has also determined specimens from Banjuwangi, Java and ? Anping. I only had the single specimen from Saida, Malacca, in my collection for comparison." Adamson states that Emerson continues by mentioning that an imago and soldiers from Mauritius agree with Barbados specimens and the "? Paratype imago" of *C. havilandi* and that he stresses the need for further study of specimens from Malay to confirm the above determinations, and states "My conclusion is that this species was introduced into both Barbados and Mauritius from the Malay region."

174. The presence of *C. havilandi* in the Customs Office (Baggage Warehouse) and in the Government Bond on the Wharf on the opposite side of the Careenage, points to some importation from abroad having brought the pest to Barbados: the species is now recorded half a mile northward and two miles southward in the congested built up area of Bridgetown; in the southward establishment the damage caused is, in some buildings, extensive and of long standing.

175. The identification of this species as an Asiatic species leads one back to Adamson's statement "If it proves to be an immigrant from the Old World, "it will be difficult to explain how it reached remote Barbados without having "been established and detected elsewhere." The fact that the species has reached Mauritius, and presumably become established there, leads Adamson to ask (in letter) "One wonders if *C. havilandi* came from Mauritius to Barbados "in return for *Phytalus smithi*." It is quite possible that direct exchanges of material with Mauritius introduced the species to Barbados.

176. Concerning the introduction of termites into Barbados, it has been known for many years that termites are brought up in wallaba wood from British Guiana, and that this wood is distributed over the Island for firewood.

177. The material so obtained has been identified by Adamson, and details of termites in wallaba wood from British Guiana are given below:—

178. In connection with the genus *Coptotermes*, it is of interest to note that Emerson records the recent identification of *Coptotermes javanicus*, Kamner, from Kingston, Jamaica: this apparently is an importation from Java. There are thus five recorded species of *Coptotermes* in the New World.

SOURCES OF INTRODUCTION OF TERMITES.

179. The hidden nature of termite infestations, and the impracticability of examining all imported wood or articles of wood which are introduced permanently or temporarily into the Island, render any check on termite introduction a difficult matter.

180. It has been stated that periodic checks are made on firewood brought to Barbados by schooners, which naturally ply mainly between neighbouring tropical or sub-tropical areas, and might therefore be considered as the most likely sources of termite introductions.

181. The principal source of such firewood is British Guiana wallaba wood, which is imported in considerable amounts annually: therefore, if termites are introduced by importation, the examination of such wood would at least provide an indication of the extent of introductions and the probabilities of permanent establishment of such introductions.

182. The results are of considerable interest: At first, attention was given to the extent and type of introduction, and it was found that 0.6 per cent. to 0.8 per cent. of the pieces of wood were infested; a piece being, on an average, a third or a quarter section of tree limb 4 to 5 feet by 8 to 12 inches diameter. Moreover the termites were invariably soldiers and workers only, in surface runways.

183. Later work showed, however, that occasionally pieces of old, dried wood infested with more than surface runways would come up in a cargo, and that such pieces contained more than a few soldiers and workers.

184. Moreover, by this time, it was possible to get West Indian termites rapidly identified by Dr. A. M. Adamson at the Imperial College of Tropical Agriculture, Trinidad, and the recent identifications of collections made throw an interesting light on introductions.

185. Thus, in two recent sendings of termites taken in Barbados from wallaba wood from British Guiana, the following species have been found:—

186. *Coptotermes testaceous*, L. which has not so far been recorded from Barbados.

187. *Termes hispaniolae*, Banks, which is also not recorded from Barbados (in this case, Nov. 14th, 1939, a queen and nymphs as well as soldiers and workers were taken).

188. *Nasutitermes octopilis*, Banks, also not recorded from Barbados, and finally *Coptotermes* sp. which Adamson suspects, is *C. havilandi*, but refrains from naming until alates are available for complete identification.

189. It is interesting that the three named species have not yet been found in Barbados, and the probability, therefore, is that they are not established here, though presumably the steady flow of wallaba wood from British Guiana into Barbados for many years has provided many opportunities for their establishment.

190. On the other hand, *Coptotermes havilandi*, which, as has been described in this paper, is one of the most serious termite pests in Barbados, and is, presumably, an Asiatic introduction, now appears as a possible, but apparently hitherto unrecorded, constituent of the British Guiana termite fauna.

191. Unless, therefore, the importation of termites in wallaba wood is a comparatively recent matter, and enquiries suggest that this definitely is not so, it seems quite possible for termites to arrive, and be distributed with the logs of firewood all over the Island, and still not establish themselves so far as has been ascertained. On the other hand, introductions of *C. havilandi* are not at all likely to have been frequent or extensive, but this species has become firmly

established, though, as stated previously, this Asiatic species is more likely to have reached Barbados from other sources than British Guiana.

BUILDINGS AND PRIVATE HOUSES.

192. A considerable number of public buildings, private buildings and houses have already been examined, and a large amount of accumulated damage has been brought to light.

193. Fortunately, in Bridgetown itself, many of the old buildings are very solidly constructed, and vital structures and supports are made of generously proportioned hardwood timbers. In some buildings examined, therefore, termite damage is concentrated mainly in laths, plates, struts, beams, door frames, doors, window frames, partitions and sometimes flooring boards, etc., though even so, the amount of current and accumulated damage is such that complete replacements of damaged structures and provision for termite control and prevention would indicate rebuilding as a preferable procedure to attempted renovation of out of date buildings.

194. It may seem strange that current and accumulated damage of this nature could exist without serious inconvenience being caused: The system of annual replacements of wood from which pellets fall, or which shows obvious signs of wood ant damage, partly accounts for this, and part is accounted for by the fact that termites usually desert a timber before it is weakened to the breaking or collapsing point. The latter class of accumulated damage is only revealed when all timbers are thoroughly sounded.

195. In many cases, therefore, serious damage is revealed when the Wood Ant Inspector is called in to make an examination, and it is certain that even a partial hurricane would reveal much unsuspected weakening of structures by termites.

196. The work carried out at present has involved the examination of Government Buildings, Schools, Churches, Offices, Warehouses, and private houses.

197. There are two definite centres of severe infestation in Bridgetown, namely the area on either side of the Careenage (i.e. the docks) and the Garrison or Savannah area. The species involved are *C. havilandi, H. tenuis* and *C. brevis*.

198. The proportion of damage inflicted by each species cannot be stated, because, in the Government Bond alone, all three species have been identified, and the extent of damage in this building is such that rebuilding has been recommended rather than renovation of an inconvenient and out of date edifice. An indication of proportional damage is given by the fact that out of 8 samples of termites collected from this building, 3 were *H. tenuis*, 3 were *C. havilandi* and 2 were *C. brevis*: it may not, however, indicate the actual prevalence in numbers.

199. In the Baggage Warehouse, only *C. havilandi* and *C. brevis* have so far been recorded, but of 8 samples, 6 were of *C. havilandi* and *C. brevis* mixed, and one each were respectively *C. havilandi* and *C. brevis*. The two species thus appear to be on an equal footing, though it is most probable that *C. havilandi* preponderated.

200. The three species dealt with above are the most damaging to buildings in Bridgetown, and of these species, *H. tenuis* is fairly widely spread throughout the West Indies and is among the most destructive of the subterranean termites.

201. *C. brevis* is also widely spread throughout the West Indies, and is the common dry wood termite found in buildings and in furniture. Both *H. tenuis* and *C. brevis* will no doubt be found all over Barbados as records are accumulated.

202. *C. havilandi* is both introduced and dangerous, but so far has not been found outside the city and suburbs of Bridgetown.

203. Both *C. havilandi* and *H. tenuis* are soil inhabiting termites which enter buildings by means of covered runways, or through cracks in cement floors or interstices in walls; *C. brevis* is the dry wood termite which has no connection with the ground but enters buildings by flying in at the mating winged adult season.

204. The soil inhabiting termites are recognised by their runways and by the fecal plaster in their workings: the dry wood termites are recognised by the presence of smooth, round fecal pellets, resembling small seeds, which are present in, or fall from, infested wood.

205. The procedure of termite examination in buildings is as follows. The wood ant inspector is provided with apparatus for sounding wooden structures, boring sample holes in them, digging into or ripping open damaged structures, so as to expose nests built in timbers, and also with a dust gun with special nozzle for blowing dry Paris green into termite galleries, a spray pump for spraying sanitary oil into nests or infested timbers, which cannot otherwise be reached or treated, and with a collecting outfit to obtain termite specimens before starting eradication measures. In addition he is provided with a labourer to assist with the extension ladder which is frequently required when working on rafters or in lofts and to supply tools and equipment when working in difficult situations.

206. Termite nests are sometimes found inside ceiling beams or in other structures well above the ground, and as these nests are made by damp soil termites, without there being any discoverable trails on outer or inner walls of the buildings, it is obvious that the termites have penetrated up the interiors of the walls. This, doubtless, is not difficult because many walls in Barbados, though thick, are built of coral lumps or rubble; termites frequently penetrate apparently solid, but naturally porous coral blocks a foot and a half thick, or more, so rubble walls would be easy work for them.

207. Termite nests are destroyed by pouring sanitary oil into them. This oil is a straw coloured petroleum distillate, water-like in fluidity, non- explosive, and cheap. It costs only ten cents (5d.) a gallon retail (9 cents by the drum), has high penetrating powers, and kills termites and queens in soil well below the apparent actual penetration of the oil: it is called sanitary oil because it is largely used by the Sanitary Authorities aganist flies and mosquitoes. If the nests are in beams or other awkward situations, the oil is pumped in by means of a spray pump.

208. Sanitary oil is now used for practically all termite extermination, except in private houses where its use might cause staining or soiling, in which case petrol is used.

209. Infested timbers are treated by boring holes in them and blowing dry Paris green into the galleries. Severely damaged timbers are ripped open and sprayed with oil or dusted with Paris green to kill the termites until replaced with sound termite proof wood. When possible, the Inspector is present at replacements to ascertain if infestation has spread beyond replaced timbers.

210. Termite trails are carefully broken at irregular intervals and dry Paris green is dusted or blown into them.

211. These measures, together with a report of timbers needing replacement, usually effect a satisfactory control over termites in buildings.

212. Before leaving the subject of damage to buildings it should be mentioned that *Nasutitermes costalis* has been found slightly damaging an estate building in the country, though by far the greatest damage by *N. costalis* is in

cane fields in Barbados. This species is quite prevalent and is a frequent source of damage to trees in Bridgetown, and is also the species which attacked a trial series of treated and untreated woods placed in a ravine in the country as detailed later.

213. The remaining species recorded from Barbados, namely *Neotermes* ? sp. n. and *Kalotermes* ? sp. n. have so far only been taken from trees in Queen's Park, Bridgetown, and there is only one record of *Neotermes* from a building.

TERMITES IN CANE FIELDS.

214. There is a variable but definitely economic loss due to the termite *N. costalis* in cane fields. Fields that are badly infested show damage at an early date, either in the form of a patchy spring or germination of the cane, due to the seed pieces being eaten out by termites, or by patches or large areas withering and drying up after having grown in an apparently normal fashion for some time. In some cases, fields which have made some months of normal growth show a general withered and browned appearance, which is considered as characteristic of very windswept fields in times of prolonged lack of rain, but which has been found by the writer on two or three occasions to be due to a widely distributed infestation of termites.

215. With good rains, the latter class of damage apparently disappears, and the fields become green again, but damage is apparent at reaping time in dead canes, and in canes which are reapable but partly eaten out by wood ants, particularly at the bases.

216. In the case of early damage to fields, causing failnre in germination, the damaged areas are replanted, and some attempt is made to find the termite nests and destroy them.

217. In the case of late damage, green immature canes and shoots are attacked and killed, and, as stated above, mature canes are killed. This damage sometimes shows in ripe fields as areas of brown or dying canes, and is attributed occasionally to root horer (*Diaprepes abbreviatus,* L.) and brown hardback (*Lachnosterna smithi,* Arrow); similarly, the patchy damage to newly planted fields, and other types of damage recorded above are sometimes attributed to root borer and brown hardback damage. An attempt has been made to arrive at some estimate of the prevalence of and damage caused by termites in cane fields, but the process of examining some hundreds of cane stools in ripe cane fields is a lengthy and somewhat arduous process.

218. So far, 76 mature cane fields have been examined, and though the fields were taken at random, only 6 of the total, or 7.9 per cent. had no termites in them. The remaining 70 fields can be classified as slightly infested, having under 10 per cent. of the stools infested; moderately infested, having over 10 per cent., but under 20 per cent. infested; and badly infested, having over 20 per cent. and up to 50 per cent. of stools infested.

219. With this classification, 42 fields, or 55.26 per cent. were slightly infested, 15 fields, or 19.73 per cent. were moderately infested, and 13 fields or 17.1 per cent. were badly infested.

220. As a standard of infestation, records of badly infested fields are as follows; 645 stools examined, 259 found infested, 20 inhabited termite nests and 8 empty nests: 965 stools examined, 386 found infested, 75 full termite nests and 25 empty: 420 stools examined, 215 infested, 3 full nests and no empty nests. In the latter case, as with other subsequent recent records, the number of infested canes and shoots was also recorded, and the damage in 420 stools was 195 canes *dead,* 73 shoots *dead,* and 152 other canes and shoots infested.

221. Another record is 569 stools examined, 193 infested; and 144 canes dead, 105 shoots dead, 176 other canes infested. Translated into total loss of crop, infestation such as the last two recorded would amount to a loss of between 4 and 5 per cent. of the crop in that field, assuming the sample to be representative of the field: a sample of 569 stools would be about 7 per cent. of the average five-acre field.

222. It can be stated, therefore, that from 76 fields, taken at random and thoroughly sampled, 92.1 per cent. were infested with termites.

223. At least 17.1 per cent. of the total fields were badly infested, and would suffer a loss of from 3 to 5 per cent. of their total crop.

224. Another 19.7 per cent. would suffer a loss of up to 3 per cent. and 55.2 per cent. a loss of 1 per cent. or less of the total crop.

225. To this must be added loss of humus in that the termites destroy an appreciable quantity of cane trash, cane stumps etc.; loss of vigour in stools which are attacked, but in which no canes or shoots are recorded as killed; and loss due to replanting of young cane fields in which termites have partially destroyed the seed pieces.

226. Though *N. costalis* is not a spectacular cane pest, there is on doubt it has to be taken into consideration, and most planters now are alive to the fact that termites or "wood ants" have to be destroyed.

227. This is done in cane fields as follows:—At the end of the cane reaping season, fields are examined and all nests treated with sanitary oil, which, as previously stated is a straw-coloured, water fluid, petroleum distillate retailed at 5d. a gallon.

228. Nests of *N. costalis* are medium sized, black, dome-like carton structures, mainly above surface, but sometimes extending several inches into the soil, and in many cases containing the queen in a cell of the hardness of concrete. If such nests are deeply punched in two or three places with an iron spike, and about two pints of sanitary oil (costing 2 to 3 cents) poured down the holes into the nest, then all termites, including the queen, are killed, though the oil may not (from field observations) actually touch them.

229. In addition to treating fields soon after reaping, periodical searches are made (or are advised) in all gullies and woods near to the cane fields. The woods are mainly small, planted areas of mahogany trees, and frequently harbour a fair number of *N. costalis* nests in forks, stumps, etc. The ravines are frequently shallow and a certain amount of bush, rocks and grass, the latter being periodically cut for fodder for agricultural purposes. Some ravines are comparatively deep and wooded, and both types harbour a considerable population of *N. costalis*. The treatment is the same in all cases, and each nest can be destroyed at the cost of 2 to 3 cents for oil.

230. In some cases, nests are found at the bases of pigeon pea (*Cajanus indicus*) planted around cane fields, and if the use of oil is not thought to be advisable in such situations, the nests or trails are broken open and Paris green dusted on to the ants.

231. The persistent searching out and destroying by oil of all nests in fields, gullies, ravines and woods is steadily reducing this pest.

232. A species identified by Adamson as *Neotermes sp.* has also been collected in small numbers from a cane field, but does not appear to be of economic importance.

TERMITES IN TREES.

233. The prevalent *N. costalis* is found damaging trees in gardens in Bridgetown, as well as causing damage to cane fields, etc. as detailed above.

234. In some cases where gardens are large and contain numerous trees, accumulated damage is severe and the ants attack outdoor wooden structures as well as damaging trees.

235. The damage is mainly to badly pruned, or broken, limbs of trees which have not been painted or tarred, and to broken branches etc. on the ground: nevertheless living portions of trees, particularly Frangipani (*Plumeria sp.*) are eaten out and killed.

236. In all cases systematic destruction of the carton nests in trees, tree stumps, and on the ground together with poisoning of all trails, followed by pruning trees properly and clearing up accumulated debris from the ground speedily effects control.

TIMBERS RESISTANT TO TERMITES AND TERMITE PROOFING OF WOOD.

237. From experience in examining infested structures, green heart, wallaba and mahogany are resistant to termite attack, but are not entirely immune: under certain circumstances termites will attack even the hardwoods, particularly so if any sapwood is present.

238. Other woods have lesser and varying degrees of resistance as is shown by the following experiments, started in July, 1936:—

239. A number of pieces of seasoned wood, 9 inches by 2½ inches by 1 inch were assembled in four series as follows:—

240. A series consisted of five treatments, each of two pieces of spruce, pine, B. C. (Douglas) Fir, birch, deal, mahogany and wallaba. One piece of each kind of wood in each series was treated according to manufacturers' instructions by painting with Atlas, Bargas, Cel-cure-sol, Noxo and Solignum, these being the preparations which are readily obtainable locally. The treated and untreated pieces were wired together, leaving a gap of half an inch between the pieces. A series thus consisted of 35 treated pieces of wood, each with its own control piece half an inch away, making 70 pieces in each of the four series. One series was buried over a foot deep in a termite infested field in the wet hilly district: one series was buried 4 feet deep at Codrington Experiment Station: one series was placed in a gully adjacent to nests of *N. costalis* and one series was placed in a store in Bridgetown.

241. The series buried one foot deep was not attacked by termites, but after periodic examination, was removed at the end of three years, and forms an interesting test of the wood preservative values of the treatment used

242. The series buried four feet deep was dug up at the end of 3 years as sound as when buried: at this depth, despite a dampness of the soil, there was no rotting even of untreated controls.

243. The series placed in the store was never attacked by termites, and after being inspected several times, the series was lost owing to the building being demolished for reconstruction

244. The series placed in the gully was speedily attacked by *N. costalis*, and after five months was brought in and examined.

245. In the latter test, the only one in which termites attacked the series, the intrinsic resistance of the woods to termites was as follows:—

246. Wallaha was not attacked at all, though in two cases out of five the control piece was built over by the termites; mahogany had two controls and

one treatment slightly damaged: deal had three out of its five controls very badly damaged: birch had three controls out of five very badly damaged, and three out of five treatment pieces damaged: B. C. fir had two controls out of five badly damaged, and slight damage to one treatment: pine suffered no damage to controls or treatments, though both were, in some cases, built over by the termites. Spruce had one control and one treatment very badly damaged.

247. This experiment was laid down primarily to test various commercial preparations and not as a test of types of wood, and unfortunately green heart wood was not included.

248. There is no doubt, however, that, as stated above, green heart wood is resistant to termites, and would last longer than fir, pine, deal, etc. Green heart timber is available in Barbados in the form of seasoned building lumber of standard requirements, obtained from British Guiana and capable of competing with other imported lumber.

249. The reasons for the present scant use of a termite resistant West Indian wood which is suitable and available for building purposes, are not within the scope of this paper.

250. The availability in Barbados of West Indian hardwoods for building purposes is, however, placed on record.

251. The protective value of treatments was as follows:—Atlas gave protection to all seven treated pieces and apparently to controls. Solignum also gave protection in all cases. Noxo protected all treated woods save birch, but did not protect its controls. Cel-cure-sol treated woods were slightly damaged in the case of B. C. fir and birch; no protection extended to controls. Bargas had four treated pieces out of seven attacked and no protection to controls. The attack on treated mahogany and deal was slight, but in the case of birch and spruce, treated pieces were badly damaged.

252. Recommendations for proprietary or commercial treatments for preserving wood against termites are therefore limited to Solignum and Atlas, and Cel-cure-sol and Noxo if desired. As will be seen from the remaining list described below, the same treatments are also the best for preserving wood from rotting. In addition to the above treatments, a test was made of "Ascu" by using it for treating wooden window frame replacements in steel and cement buildings in the Department's grounds. Soil termites penetrate the concrete floors and partially hollow walls of these buildings and attack window frames, etc., without forming any external trails: each year, therefore, some window frames, etc., have to be renewed, and such renewals were treated with "Ascu." This material is not known to be stocked commercially in Barbados.

253. Subsequent annual examinations have shown that wood treated in this manner has not been attacked by termites, though adjacent untreated wood has been attacked.

254. The third series which was buried a foot deep in an infested cane field was not attacked, and was finally dug up in July, 1939, three years after being buried: though not attacked by termites, rotting of the wood due to fungi had set in.

255. This series, therefore is of interest as a comparison of the wood preservative powers of the five treatments and of the intrinsic resistance to rotting of the various woods. In all cases there was an intrinsic superiority of wallaba, mahogany and pine over the other woods. Birch, deal and fir all showed considerable rotting of the control pieces and spruce showed slight rotting. In many cases a marked preservative effect due to the treatments against termites was apparent.

256. The three treatments which gave the best results in termite proofing were also the best preservatives, though none was perfect. Cel-cure-sol had a definite advantage, though it failed to preserve the birch piece.

257. As a result of these tests the Department is in a position to give recommendations on commercial termite proofing materials which are readily available in Barbados to all who wish to treat structural, or replacement, timbers with a view to making them proof against termite attack.

258. It is recognised that proprietary termite proofing materials are, in many cases, higher in price and in the claims made as regards effectiveness than their constituents warrant. Nevertheless, the public appears willing to pay a higher price for an article which is ready for immediate use rather than to use home-made preparations.

259. The use of zinc chloride has frequently been recommended to enquirers in the form of a 5 per cent. solution of zinc chloride in water which can be used for termite proofing wood which is for internal use, and which is to be painted or polished.

260. For outdoor woodwork, which has not to be painted, creosote is a satisfactory inexpensive treatment.

261. The main difficulty encountered up till now is to make people understand that all surfaces, including edges and cut ends, must be thoroughly treated, and that treatment must be made before the timbers are put into the final position. By thorough treatment is meant the application of an even coat of preservative applied with a flowing brush so that there is an unbroken surface of wood well soaked by preservative.

262. The practice, which is at present all too prevalent, of painting exposed surfaces of new timbers after they have been cut and fitted into position, can only give very partial, if any, protection, inasmuch as the inner surfaces and cut ends by which the termites mainly enter, remain unprotected.

263. The combination of thorough treatment of new or replacement timbers, and of thorough inspection of buildings, coupled with destruction of termite nests before starting renovation work, is a definite advance towards control of termites in buildings in Barbados. To this can be added greater consideration of the use of West Indian hardwoods, and careful painting of exposed wood surfaces so as to leave no unprotected areas for the entry of termites.

PREVENTIVE MEASURES AND CONTROL.

264. The total extent of termite damage in Barbados does not yet appear sufficient to lead to any adoption of the incorporation of termite proof metal courses in the foundation of newly constructed buildings. At present, advice on termite proofing the many new houses and buildings being erected in Barbados is never sought, though available at the Department, and it may be some time yet before prevention is preferred to a cure. It is hoped that in time the demand for inspection of buildings already damaged by termites may lead to enquiries for methods of prevention.

265. There is also at present no enquiry from the importers of lumber regarding prevention of losses to stored timber, or for the construction of tanks for the mass treatment of timber against termites.

266. The fact that the various lumber yards in Barbados have never yet reported any damage to stored timber, due to the depredations of wood ants, does not mean that termites are not present, nor that loss is not incurred.

267. A measure of prevention undoubtedly rests witb the public wbo could
(a) examine carefully the lumber they buy:
(b) insist on seasoned wood only and heartwood instead of cheaper grades containing much sapwood:
(c) treat all timber before the final fitting into position with a recommended preservative:
(d) maintain exposed painted surfaces in good condition, as an unbroken painted surface is a good protection against termites.

268. A further measure for the prevention of infestation is an increasing use for building purposes of green heart and other hardwood lumber from British Guiana. It is understood that this lumber can be obtained in quantity, quality and price which will enable it to be used for most purposes for which other lumber is now used. It may be harder to work, but would be more durable and less attacked by wood ants.

269. It has been stated in this account that much of the damage revealed so far is accumulated damage, and it is possible that the present methods of expert examinations and surveys of buildings, when required, destruction of nests when found by means of sanitary oil, and of hidden nests by systematic poisoning of runways with Paris green, plus renovation of damaged structures with properly treated or resistant timbers may prove sufficient for termite control in urban areas. The adoption of the preventive measures outlined above should greatly reduce the amount and frequency of accumulated damage.

270. In country areas, where tbe principal damage is to cane fields, the systematic destruction of termite nests as recommended in fields, gullies and small woods will reduce infestation to a minimum.

SUMMARY.

271. At least six genera and seven species of termites are present in Barbados.

272. Three genera and species cause damage to buildings mainly in Bridgetown; they are *Coptotermes havilandi* (Holmg.), *Heterotermes tenuis*, (Hagen) both damp soil termites, and *Cryptotermes brevis*, Walker, the dry wood termite.

273. *Coptotermes havilandi* is an Asiatic species, and Barbados is the first record of it in the New World.

274. *H. tenuis* and *C. brevis* are widely spread throughout the West Indies. Other species, found in regularly imported firewood from Britisb Guiana, but not so far known to he established in Barbados, are recorded. The damage to buildings is described.

275. The ubiquitous *Nasutitermes costalis* (Holmg.) is widely spread throughout Barbados, and causes a varying amount of damage to the main crop, sugar cane. The extent of damage, as shown by preliminary survey is detailed, and the measures which are being put into practice for the control of *N. costalis* are outlined.

276. A series of experiments to test the value of materials available in the local market for preserving wood against termite attack are detailed; the same experiments also gave useful indications of the resistance to termite attack and to wood rot inherent in various kinds of woods. The value of British Guiana green heart wood now available as standard building lumber is indicated.

277. An account is given of the measures to combat termites in Barbados. The principal measure is the wholetime employment of a temporary officer to inspect buildings, cane fields and inter-island schooners, and who reports on extent of damage and carries out or advises on control measures.

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BUFO MARINUS L. IN BARBADOS.

BY

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278. The giant toad, *Bufo marinus,* is of interest and importance in Barbados. It is important because it is a recognised and accepted natural control over the two coleopterous pests of sugar cane, namely *Diaprepes abbreviatus* and *Lachnosterna smithi,* and probably over the cane weevil *Metamasius sericeus.* It is of interest because, having been introduced into the island over 100 years ago, it can now barely maintain itself at a low population level on account of lack of suitable water in which to breed, oiling of water against mosquitoes, and the attacks of its own enemy the giant water beetles (*Dytiscidae*), of which there are two species recorded from Barbados, namely *Hydrophilus ater* and *Megadytes giganteus.*

279. Because of its usefulness, and because of the scarcity of suitable breeding places, an attempt has been made to induce planters to build suitable artificial pools for it, such pools being kept free from mosquitoes by stocking them with 'millions', a small fish which feeds on mosquito larvae.

280. To this end, a cement pool was built in the Department grounds and observations have been carried out over a period of years to ascertain the life cycle, seasonal prevalence and habits of this giant toad. As will be seen, it is easily bred in artificial ponds but has the majority of its broods destroyed by the larvae of the above-mentioned water beetles.

OCCURRENCE IN BARBADOS.

281. According to Schomburgk, *Bufo marinus* was introduced into Barbados presumably from British Guiana about 1830, and was, in 1848, present all over Barbados in large numbers.

282. The fact that it is not present in large numbers now can be ascribed mainly to the disappearance of surface water and natural shelter. Thus H. A. Ballou (1) states "According to this observer (Dr. C. J. Manning in Education "Gazette, August 1914) the planters of Barbados have completely changed the "physical aspect and conditions of the Island during the past fifty years. "Formerly, each of the 400 and more estates in the Island had at least one "pond and most of them had more, and it is estimated that there were over "1,000 ponds, all brimful of water during the rainy season................ Now the "ponds have all been drained, many pastures have been planted, ravines and "gullies have been very much cleaned so that they provide for a quick run off "of the water. The trees have been cut down to a very large extent."

283. It is not considered by Ballou that the mongoose is a serious contributing cause to the diminution, because the poisonous secretion of the toad would be an effective protection.

284. The reduction in numbers of the toad in Barbados is therefore attributable as stated above to the lack of water and damp places for breeding, and to diminution in natural shelter; to which has been added a steady increase in the human population of the Island, a more extensive use of the land, and the serious effect of the predaceous larvae (known locally as pond dogs) of the giant water beetles *Megadytes giganteus* and *Hydrophilus ater.*

285. In 1935 it was stated (2) that "As its value in the control of cane "pests is realised, it is intended in Barbados to try and breed it artificially,

"*so that controlled supplies may be created, and thus allow this predator to*
"maintain and increase its beneficial work."

286. It was also considered that the artificial breeding of *B. marinus* needed investigation to determine seasonal variations in probable abundance, numbers reaching the dispersion stage and any causes of mortality, in order that if advice was to be given to the planters it would be based on knowledge of the type of pond and conditions suitable to the toads, together with some idea as to the rate of increase to be expected.

287. For this purpose, an artificial pool was built of cement in the Department's grounds and observations carried out over a period of two years and nine months.

288. The making of observations and recording of results was left largely to Mr. C. C. Corbin, Third Agricultural Assistant, and most of the statements on life cycle, seasonal abundance, etc., are based on his recorded observations.

OBSERVATIONS ON BUFO MARINUS.

289. The experimental pond built was oval, eleven feet long and eight feet greatest width; it was seven inches deep at one end, and eighteen inches deep at the other end, at which end there was a drainage pipe through which the pool could be emptied.

290. A pile of rocks was placed in the centre, to provide both a shelter and a resting place; water lilies in tins and shallow boxes were placed in the pool.

291. The pool was constructed in this fashion in order to make observations on numbers, development stages, etc., easier. A low wire fence was also erected around the pool, and creepers were planted on the fence, and shrubs, ferns, grasses, etc., in the enclosure itself.

292. In view of the comparative shallowness of the pool, it was constructed where partial shade was available to avoid as far as possible heating of the water by direct rays of the sun. Unfortunately, the only shade available in a spot suitable for the pool was that given by Tamarind trees, and in consequence the pool was almost constantly littered with the small leaves which such trees shed; also water lilies in pots, etc., never thrived in the pool so that natural shade and shelter could not be established. In addition, there were more attractive natural breeding places for the toad within about 300 yards; also a very large artificial pool in the neighbouring Queen's Park.

293. Probably for these reasons, the toads very rarely came to the pool *of their own accord though the gate of the enclosure was left open.* At first, the pool and enclosure was stocked with toads and the gate kept closed; it was found, however, that it was difficult to get enough food to keep the toads fat and thriving. Appeals were made to planters to bring in regular supplies of living root borer and brown hard back beetles; the response was so poor that it was found impossible to keep the toads supplied with natural food. Various artificial foods were tried, but the toads did not thrive and showed no inclination to breed. The gate was therefore left open and the toads dispersed.

204. This indicated that an artificial pool, to be successful, must not be anywhere near a possible natural or larger, breeding area, and must not be fenced in; the toads must be free to come and go in search of food and the pool must be deep and large enough to maintain natural shelter in the form of water lilies, weeds, etc., in which the toads can find shade, hiding-places, and resting places.

295. Such pools, however, are not too well suited for observation purposes.

296. The next step was to take mating, or at any rate fully adult toads from the neighbouring breeding grounds and put them in the enclosure.

297. When this was done, characteristic egg strings were laid in the pool and observations could be carried out. No attempt was made to count the number of eggs deposited by one pair; it is known that this runs into several thousands. What was ascertained was the developmental periods, causes of mortality and numbers of young toads which reached the self-supporting dispersal stage.

298. Altogether twenty-three broods were observed over a period of two years and nine months, starting from January, 1937.

299. Of these, only ten broods reached the four-legged dispersal stage. Ten broods were destroyed by pond dogs and three broods disappeared before hatching; whether this disappearance in the egg stage was due to infertility resulting in rapid dissolution, or to cannibalism or a predator is not known. The usual but not inevitable procedure following the fertilisation of a string of eggs is for the toad to gather the long and usually widely distributed string into a ball, from which the young tadpoles subsequently hatch.

300. The period between deposition and hatching varies but can be taken for local conditions as between three and four days. Out of twenty recorded hatchings, one record is of five days, eight of four, seven of three days and four of two days. The five-day record was made in January which is usually the coolest period of the year. The fifteen records of four and three days were made in all months, including December and February, also cool months. The four records of two days from deposition to tadpoles were made in the hot summer months only.

301. Allowing for the general nature of the observations, it seems that a period of three to four days from egg laying to hatching is usual, with a slight lengthening or shortening of the period due to climatic conditions.

302. Moreover, hatching is by no means a simultaneous process; some tadpoles emerge several hours before the main hatch occurs.

303. Subsequent development is also irregular, and after several days a proportion of tadpoles are more than twice the size of others of the same brood. In consequence, some tadpoles develop legs whilst others of the same brood are still small, and some reach the young toad stage ready for dispersal whilst others have two legs only or no legs at all.

304. This differential rate of development is at times confusing because though, as stated, most mating pairs were put into the pond, there were cases in which toads entered the enclosure and the pond of their own accord and laid eggs during a period when a previous brood was under observation.

305. Nevertheless, it can be stated from the records available, that from hatching to fully developed young toads takes about three weeks; the figures recorded are 28, 26, 28, 18, 26, 19, 13, 21, and 34 days, giving an average of 23.6 days. One period of development not included in the foregoing was as long as 47 days, but this was in February and may be due to cooler weather.

306. The other records are from April to September, the majority being in June and July; this is of interest inasmuch as the period of apparent greatest toad increase is in the summer period, which is also the rainy period, and also the period of greatest abundance of root borer and brown hard back beetles and other insect pests.

307. Though, as stated, a single deposition of eggs will run into several thousands, and though hatches are almost always complete, the greatest number of young toads recorded as surviving from any brood is 300, and the lowest record is 75. These figures are probably under-estimates, for young toads are difficult to see and can easily escape through the wire mesh of the pool enclosure.

308. Mortality appears to be largely due to inherent weakness of some of the brood, whereby, as has been stated, some tadpoles scarcely grow at all and others develop rapidly in size and vigour. There is thus a steady decrease in the numbers of tadpoles, though only occasionally can dead ones be seen. The tadpoles in an observation pool as described gather from time to time in dense masses, swimming but staying in one spot, or else they mass together motionless at one or two spots on the pool floor; at other times, they all swim freely in every direction.

PREDATORS.

309. The only known predators in Barbados are the larvae of giant water beetles, Dytiscidae, of which two species are recorded in Barbados, namely, *Megadytes giganteus* and *Hydrophilus ater*. These can be present in such numbers that on one occasion 71 larvae of all sizes, and two adult beetles were killed over a period of four days. Usually, infestations only amount to a dozen or so of these predaceous larvae, but that is quite sufficient to kill an entire brood of tadpoles numbering several thousands.

310. With a clear shallow pool such as has been described, both beetles and larvae can be seen, and by patient waiting, the larvae can be netted or lifted out on wooden spatulas and killed and the adults crushed by means of a heavy wooden bar. If the water is turbid for any reason, then the pool is promptly emptied, and the pile of rocks in the centre removed and dried, rather than allow a population of water beetles to accumulate; it was found that if such precautions were not taken the Dytiscid larvae crawled out of the pond, when mature, and pupated in the soil of the enclosure.

311. *In estate ponds, such as one described later, no control over Dytis*cidae appears possible; and in shallow, natural, but temporary rain ponds the writer has seen Dytiscidae and their larvae in abundance but tadpoles are rarely seen; and if by any chance tadpoles and not pond dogs are seen, it is almost a certainty that the ravenous predators will appear before the *Bufo* brood has a chance to mature and disperse.

In large estate ponds that are kept mosquito free by means of periodic cleaning of weeds, grasses, etc., and establishment of 'millions' for mosquito larvae control, *B. marinus* of various sizes can usually be found, and at shallow edges tadpoles can be seen. Presumably in such cases the fecundity of *B. marinus* and the size of the pond enables sufficient of each brood to escape.

313. It is unfortunate, however, that rather than take the necessary precautions of weeding and stocking ponds with 'millions' and so enabling *Bufo* to breed, most estates drain the ponds and other estates oil their ponds to comply with mosquito control regulations; the result in the latter case is not only unsightly, but at times odorous on account of the number of toads which are killed.

ESTATE POOLS.

314. Despite the professed desire of the planting community to protect and multiply the giant toad, and although the toad offers a possible alternative to the recommended but only partially adopted controls over root borer and brown hard back pests of cane, the writer knows of only two estate ponds, constructed solely for breeding *B. marinus*. Both pools are on the same estate, and the first one was given ample trial over two or three years.

315. *This original pool was an* oblong 17′ by 15′, with two sides vertical and two sloping. The pool was 2½ to 3 feet deep and had a mud bottom in which

water lilies grew abundantly. Dozens of toads could be seen by day sheltering among the flat water lily leaves, and from the wing cases of the root borer *Diaprepes* seen in the water, and remains of *Lachnosterna*, the brown hard back, seen in toads' excreta on the cement borders of the pool, it is obvious that the pool was serving its purpose. No other suitable water was near, and broods of tadpoles have been seen in this pool. With the exception of an occasional barrel of water added in very dry weather, the pool needed no special attention.

316. The construction of these estate pools certainly deserves more widespread attention.

FOOD HABITS OF B. MARINUS.

317. Many lists have been published of the stomach contents of *B. marinus*. The writer has made no attempt to kill and dissect a number of toads because, in the first place, if they had any harm to do to local fauna, such as a weaker species of *Bufo* or to frogs etc., it has already been done during its long years of establishment here. In the second place, it is a foregone conclusion that the stomach contents would depend entirely on the locality and conditions of capture; in fact it would be more interesting to guess the locality of capture of each toad from the stomach contents, than to speculate on the toad's value as a control over noxious insects.

318. So far as Barbados is concerned, it is known to frequent cane fields, and is known to feed on *Diaprepes* and *Lachnosterna*, and is also known to feed on cotton worms and other defoliators; moreover, it does not despise the cockroach.

319. Therefore, if it occasionally eats a beneficial insect, it is probably from chance, not habit; and if it beleaguers bee hives, and it undoubtedly does if it gets the chance, the remedy is to raise the hives at least two feet from the ground, or enclose them with a proper fence, the toads will, it has been found, crawl up and over a two and half foot wire mesh fence, even though the top of the wire is slightly curved over.

SUMMARY.

The giant toad, *Bufo marinus*, has been established in Barbados for so long that it is now the dominant insect predator.

2. Its numbers are severely limited by lack of breeding places, by intensive cultivation, and by the predatory larvae of giant water beetles, *Dytiscidae*.

3. A long series of observations have shown that broods of *B. marinus* can be raised in a comparatively shallow artificial cement pool, provided *Dytiscidae* are controlled, but that it is better to use large, deep pools in which the abundant shelter of water lilies can be provided.

4. Life history records show that the main breeding period is in the wet, warm months, though broods have been raised in every month. This main breeding period also coincides with the seasonal peak prevalence of the cane pests *D. abbreviatus* and *L. smithi*.

5. The usual period from egg deposition to hatching is three to four days, and from newly hatched tadpoles to dispersal stage as small toads is on an average between twenty-three and twenty-four days; there are minor seasonal variations.

6. As the toads will take to, and breed readily in, suitable artificial pools, the construction of such pools on estates is recommended. The pools should only be constructed well away from natural water, and in a position where an occasional barrel of water can be carted to freshen the pool in dry weather.

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